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ENVIRONMENT VIEWS

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Soils And The Environment

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ENVIRONMENT
VIEWS

Contents

Soils — a Living System 3
Humankind will always need productive, carefully-conserved soils.

Viewpoint 7
There's more to soils than muck, mystery and motherhood.

Why Farmers Worry 8
Solonetzic soils, acid soils, erosion and summerfallowing are prime concerns.

Our Depleted Soils 11
The soils' worst enemies are wind, water and mankind.

The Contamination Threat 14
The land cannot absorb our castoff chemicals.

Alberta's Changing Pattern of Soil Use 17
Climate, farming practices and politics have altered our approach.

Beneath the Forest 21
Forest soils are still new territory for research and management.

Researching a Non-Renewable Resource 24
Soil scientists feel the pressure to increase food production.

The View from 900km 27
A remote-sensing program keeps an eye on Alberta soil conditions.

Global Perspective 28
We have steadily lost ground in our struggle to feed and shelter the world.

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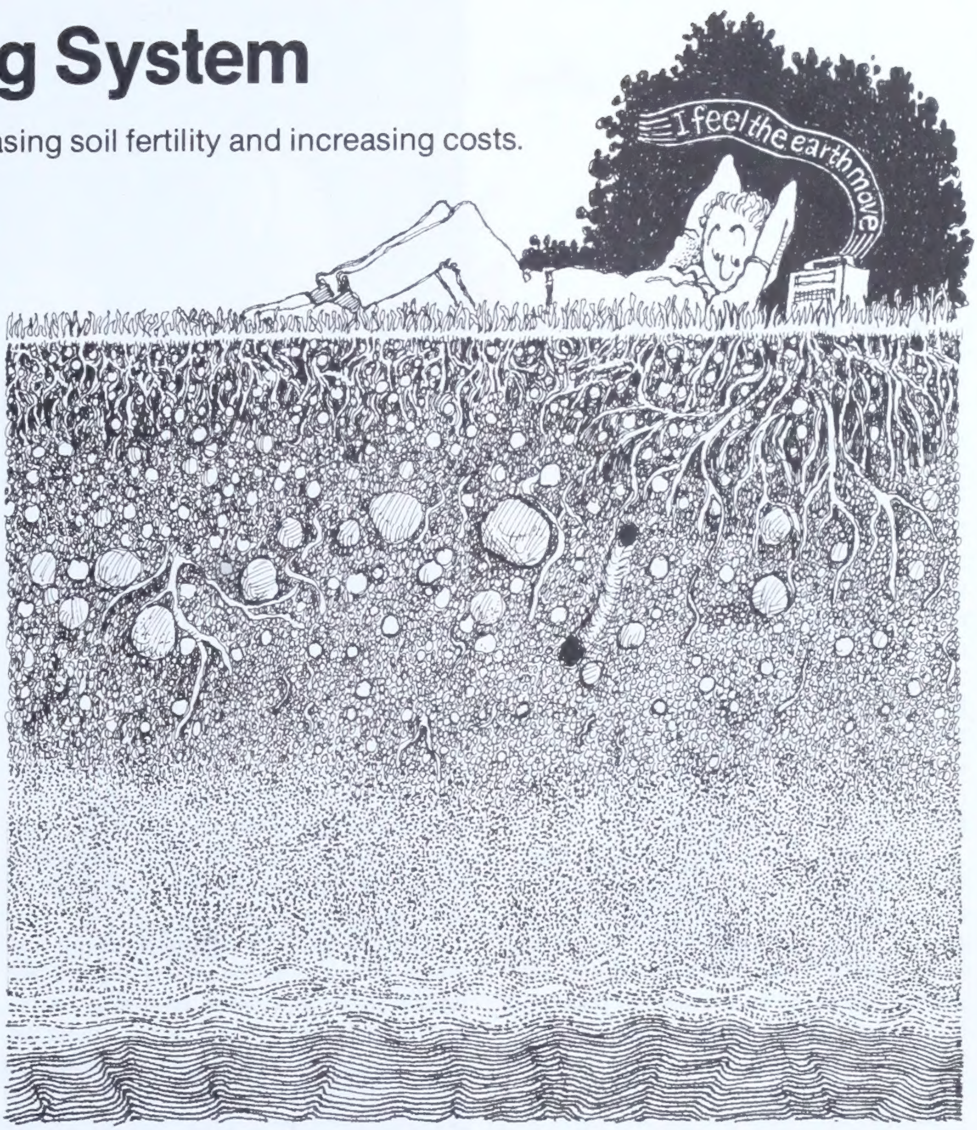
Alberta
ENVIRONMENT

Introduction: Susan Mayse

Soils — a Living System

Farmers are caught between decreasing soil fertility and increasing costs.


I feel the earth move

'Out of sight,' says the proverb, 'out of mind.'

All too often unseen and unconsidered is that stuff lying at the bottom of it all, the nitty-gritty foundation of the world we inhabit: soil.

Soil is "the naturally occurring, unconsolidated, mineral or organic material at the earth's surface that is capable of supporting plant growth," by Agriculture Canada's definition.

Alberta's 66 million hectares aren't all soil, of course. Waterways, lakes, bedrock and glacial material account for thousands of hectares — then there are sprawling new areas of concrete and asphalt which have sprung up in place of parkland and prairie. Still, the living and constantly changing surface of the province, as on the rest of the globe, is mainly soil.

Six broad categories describe Alberta's soils: Brown Soils, Dark Brown/Thin Black Soils, Dark Gray/Dark Gray Wooded Soils, Gray Wooded Soils, and Problem Soils — mainly solonetzic, saline or acidic (see map). Each zone has different native plants and different soil characteristics, depending largely on climate.

Several factors combined to create them — moisture, temperature, and biological activity in particular — just as many more agents today keep them altering in an endless evolution.

Retreating glaciers about 10,000 years ago started the process of change that gave us our present soils. Two immense ice-flows scoured most of the province's surface free of earlier soils, and deposited tonnes of boulders, gravel, clay and silt which became 'parent material' to new soils.

Over centuries, rain and snow fell to moisten the barren material and create an attractive growing medium. Warming climate conditions encouraged vegetation, and its decomposition. Plants took hold tentatively at first, then burgeoned into the lush headlong growth of parkland, prairie and forest.

Generation after generation of trees, shrubs, flowers, grasses, even minute lichens flourished and died, adding their bodies to the gradually enrichening soil — on the surface. Beneath, out of sight of the keenest-eyed prairie falcon or native hunter, even more urgent life teemed and regenerated.

Two fundamentally different conditions of soil growth still affect our land use today. Some soils developed under grassland, which produced organically rich well-mixed soils, while others developing under woodland resulted in crusted, layered soils which respond poorly to cultivation.

Alberta's early native peoples had a sure sense of earth's harmonic cycle, yet even they could scarcely have known the complexity and interdependence of the hidden life underfoot. Down below ground level seethes the riotous world of plants' root systems, bacteria, fungi, and small animals such as worms and insects.

The biomass — the living or once-living content — of soil is many times greater than the amount of surface life it supports. A single gram of rich soil might contain a billion microbes; a plowed one-hectare field might yield nearly seven tonnes of these microscopic animals.

"It takes a lot of trying to convince people that just because you don't see it doesn't mean it isn't there and active," says the head of the University of Alberta's soil sciences department, Dr. Bill McGill.

"I view soil as a continuously unravelling thing, like a book that's always being written as you're reading it. If you want to stop reading after five years that's fine, but it doesn't stop the book from being continuously written," he says.

One environmental theory suggests that our planet is a single, huge, enormously complex organism. Although many biologists find this an extreme view, it's useful as a way of thinking of soils. Soils not only form a living, dynamic system — they also form a global system.

Human activity or geological activity on highland soils will quickly affect the soils of plains below. In the 1930s, topsoil stripped from prairie farms blanketed eastern Canadian townships. Farmland near Mt. St. Helen now lies under centimetres of barren volcanic ash, creating yet another layer of the changeable soil.

As well as thriving with organic life, the soil cycles most of the solar energy the planet receives every day. Only about four per cent is used by plants. The rest passes on its way — regulating earth's temperature, travelling back into the atmosphere through leaves, or radiating outward as heat. And solar energy is locked away in earth's deep storerooms transformed into oil, gas and coal pressed from long-dead forests.

Soils wrote human history in a sense, too. After the last onslaught of glaciers, peoples of the Tigris-Euphrates basin augmented their surface pursuits of hunting and gathering with the purposeful task of delving below the soil surface to plant and harvest new foods. Agriculture indelibly drew the line between Asian and European prehistory and history.

What if the Americas had developed undisturbed another century or two? The successful farming of the Five Nations, the Hopi, and the Maya could well have yielded advanced technology and written history. Perhaps in time they would have degraded their soils and migrated to greener pastures, as did the peoples of early India and Mesopotamia (see story page 28).

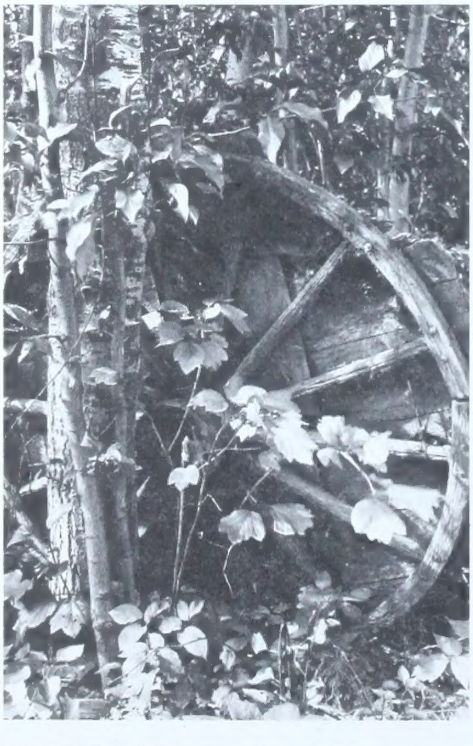
Alberta's native people were not farmers, but when Europeans set eyes on the aspen parkland between present-day Edmonton and Calgary, what they saw was farmland — rich, fruitful, ready for the plow.

Southern Alberta was another matter — a highly political matter. In 1857 Captain John Palliser, commissioned to study the plains, accurately dismissed the dry southern region as almost useless for agriculture. But bureaucratic red tape buried his report, which could have spared much hardship in years to come, under more favorable comments (see story page 17).

Provincial Archives of Alberta, E. Brown Collection

'The Last Best West' was the slogan that launched one campaign to attract homesteaders. In areas with good soil, dependable water and an adequate growing season, it was true. In the first years of agriculture, the soil was generous. Farmers harvested award-winning wheat and barley, and plenty of it. The first western Canadian wheat was shipped to Ontario in 1876, and it looked as though the prairies' reputation was assured as 'Canada's bread basket.'

The late 1920s brought a shocking first alarm, as tons of prime topsoil lifted on hot prairie winds and swept eastward. Farms were abandoned, towns crumbled under the assault of dust, the very life of the west seemed to be eroding like the misused soil.



Alberta Government Photo

Poor management had stripped the land of its topsoil, but rapid control measures managed to halt and even reverse the damage over time. Strip cropping, shelterbelts and leaving 'trash' or straw on the fields all did their work. Abandoned farms were reoccupied. New crops sprang up. Tall tales in the prosperous 60s described rich grain farmers with mile-long cars and half-section swimming pools — reflecting not truth, perhaps, but an optimistic farm economy. Everything would be fine — modern technology had triumphed.

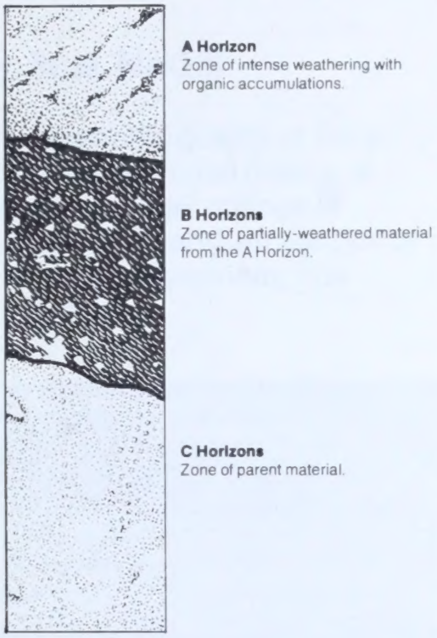
Then yields started to level off in the 1960s. Everything wasn't fine.

The soil had been depleted of its nutrients by a combination of our time-honoured and sometimes damaging agricultural methods — wheat-fallow monoculture (growing wheat, alternating with leaving the land uncultivated in summerfallow), burning stubble each fall, permitting wind and water erosion by using tillage for weed control — all methods which prevent the return of organic matter to the soil.

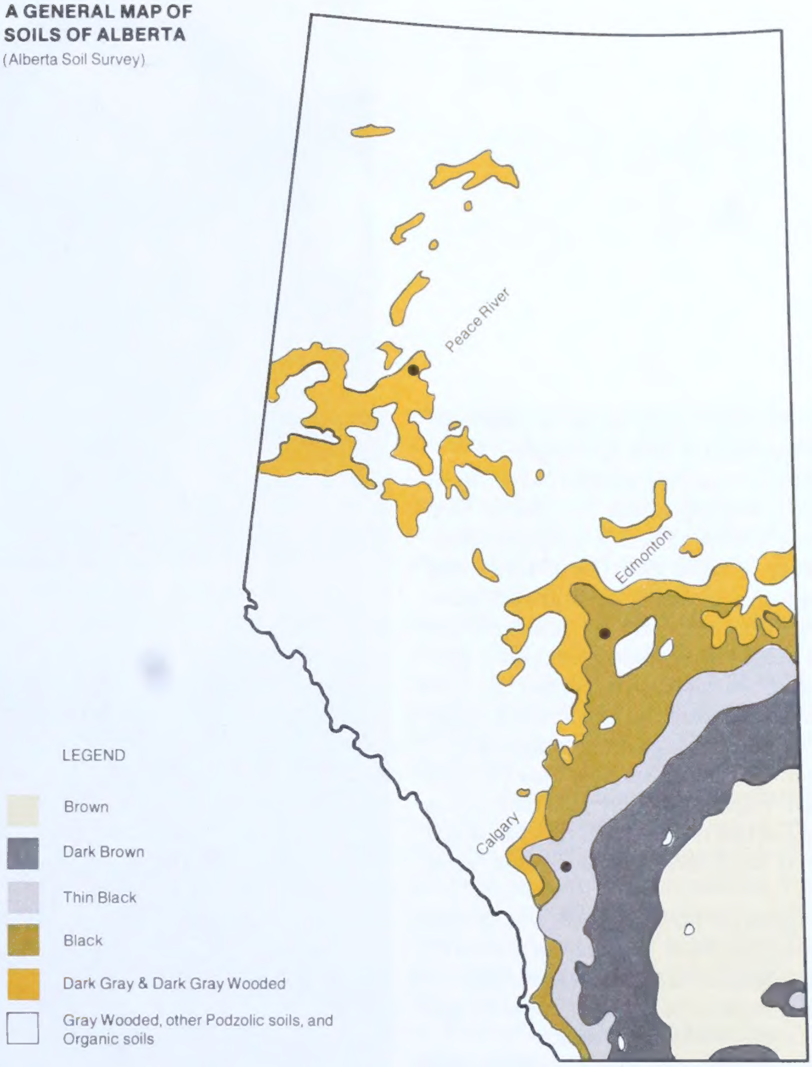
Fertilizer to replace the farmed-out soil nutrients, especially nitrogen, had always been cheap and easy to apply — until our first awareness of world energy shortages in 1973. Prices for energy-intensive nitrogen production soon skyrocketed, but it was even more expensive to return nitrogen to the soil by the non-chemical method of crop rotation including a forage crop — and nitrogen depletion is only one concern among many.

Today, farmers are still caught between decreasing soil fertility and increasing costs,

A SOIL PROFILE


A Horizon
Zone of intense weathering with organic accumulations.
B Horizons
Zone of partially-weathered material from the A Horizon.
C Horizons
Zone of parent material.

A GENERAL MAP OF SOILS OF ALBERTA
(Alberta Soil Survey)


Peace River
Edmonton
Calgary
LEGEND
Brown
Dark Brown
Thin Black
Black
Dark Gray & Dark Gray Wooded
Gray Wooded, other Podzolic soils, and Organic soils

anxious to conserve the soil that is their livelihood, but forced to maintain half a million dollars or more in land and equipment.

"Farmers must function within an economic system over which they have almost no control," says McGill. "They must buy all their inputs at a price set by the seller, and they must sell all their outputs at a price set by the buyer. The only way you stay alive is by being able to keep a bit of a difference between your costs and what you can sell."

'Land mining' is an accusation that has been levelled at western farmers — exploiting the land ruthlessly over a short period to extract its wealth, then abandoning it. In fact, this has almost never been the case in Alberta, where family farm managers tend to plan ahead not for next year's harvest but for harvests three generations distant — finances permitting.

Ignorance, not greed, has caused most soil disasters in the past. There was simply no one to warn that over-irrigation might cause soil salinity, that too much tillage was an open invitation to wind erosion, that above all, the soil must retain its organic matter to continue to produce crops.

Technology didn't come to the rescue — not because it was unable to meet the challenge, but because agricultural research dollars went elsewhere. Soils, taken for granted as an unchanging constant, remained unstudied while researchers applied their scant funding to plant and livestock breeding, farm engineering needs, a score of other topics.

Researchers share any blame for the lack of soils projects, says McGill — they should have been more persuasive or insistent in their demands. Lack of basic information has occasionally led to faulty conclusions.

"Sometimes the reason we have no evidence is that nobody has ever looked — and if you never look for something it's easy to say we have no evidence that it is there."

The Agriculture Canada Soil Survey has been at work for decades mapping the province's soil types in detail. With some information 40 years old gathered on a broad scale, the essential survey will be compiling data for years to come. Once the soils are located and identified, their capabilities and potential can be assessed.

"There is an enormous restriction on what we can grow, based on climate. People think black soil is A1, the top soil, but there are lots of areas where it won't even grow forage crops," says Dr. Wayne Pettapiece, unit head of the federal soil survey.

"I think what we need is a good solid inventory of the soil resources — having that, we can put specifics of productivity on that resource."

Other soil research dates back a valuable half-century, but has had to fight for its very existence over funding (see story page 24).

While we lack full information on what takes place between plants and soil in agriculture, the data is abundant compared to what's available on forest soils. Foresters in the past were forced to extrapolate the growth needs of timber and recreational forest from the needs of agricultural crops — and a tree is altogether different from a wheat field.

Now, with energy costs climbing steadily and soil fertility slipping, the soil and its scientists have presented us with an ultimatum: conserve.

The warning is heeded. New concern for the soil has swept environment and agricultural circles. But is there time to forestall soil-related farming disasters around the world?

D.A. Rennie, in The Agrologist (fall 1979), writes of the dangers of depleting the soil.

Soil mismanagement practices "leading to serious degradation of soil quality in prime agricultural land, which occurred in Europe some 200-300 years ago, in the Anatolian Plains of Turkey in the present century and which destroyed many early civilizations, are presently active here in Canada."

A grimmer warning comes from F. Kenneth Hare, writing in the Journal of Soil and Water Conservation (May-June 1980).

Because of rapid clearing of forest and grassland on a global scale, and enormous fossil fuel consumption, increased carbon dioxide in the atmosphere may cause a general heating of the earth's surface. Cooler areas such as Canada and Scandinavia might benefit — desert-fringe areas would not.

"There may be irreversible losses of soil, perennial vegetation, and livestock, even famine. The recent Sahelian crisis rehearsed the effects for a largely uncomprehending world."

The greatest hazard, he notes, is that countries most likely to suffer have poorly-organized technically-lacking governments. Counter-measures to drought could be politically or physically impossible.

Countermeasures — to soil depletion and misuse, the present concerns — should be within our capability in Alberta.

But what are those solutions?

Agreement about the answers is even less forthcoming than agreement about the nature of the problems, among soil scientists. United in their concern for the soil, they are nonetheless divided over their approach.

More nitrogen and other fertilizers, advise some specialists, will replace depleted soil nutrients and keep yields high.

Only forage crops, others claim, can return both nutrients and organic matter to the soil.

Minimum tillage — cultivating the land as little as possible — would reduce erosion hazard and keep more plant matter in the soil, some say.

Old-fashioned barnyard manure is our sole hope, say still others — notably the advocates of eco-agriculture or organic farming.

Organic farming in the past was associated mainly with back-to-the-land communes, but increasing numbers of farmers now regard it as a viable commercial alternative.

Alberta Government Photo

Former American agriculture secretary Earl Butz in 1971 took a dimmer view, saying if North America switched to organic farming now, 50 million people would starve.

Most soil scientists and farmers, however, will agree in principle to any of the above recommendations. There's a grain of truth in each, but as always with soils, the very complexity of the system demands complex answers.

Take the case of anhydrous ammonia, which is applied to crops as a nutrient. Plants may use it immediately, or under some conditions it may be stored in the soil as a nitrate and used later. It adds nothing plants don't need. More plants grow, and decompose to add some organic matter to the soil — several pluses.

Ammonia does kill valuable plant bacteria in the exact spot of application, however, and may accelerate decomposition — two minuses.

It's a tradeoff, as usual, between loss and gain, depending on the individual soil. And as usual, we don't yet know as much as we should about the whole process, through lack of research.

Sound unpleasant?

Our ancestors — faced with a depleted and decreasingly fertile soil — would have rounded up the cattle and seed stock, then headed across the mountain or sea to discover untouched new farmland. Now, there is no such commodity.

By necessity, agriculture has collectively arrived at the concepts the more far-sighted identified some time ago: stewardship, conservation, preservation. They apply to the earth's surface as readily as to the beasts moving over it, or the plants growing with its sustenance.

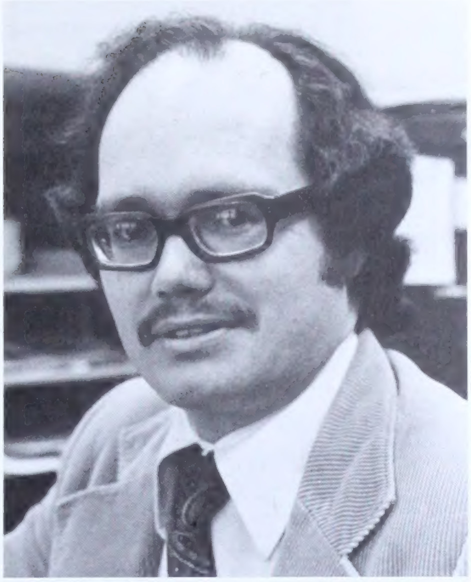
Humankind will always need a productive living soil, and ensuring that it always has one is among our most urgent tasks today.

Susan Mayse is the acting freelance editor of this magazine.

VIEWPOINT

Dr. W.B. McGill

"The essential quality of life is living; the essential quality of living is change; change is evolution . . . and we are part of it." — John Wyndham, *The Chrysalids.*


Lauren Dale

Soil degradation and loss are concerns in Alberta and globally. Little is generally being done about it. A fundamental change in the perception by society of soils, their functions, and their availability is needed in the next 20 years.

Soils feed the world. A 60 per cent increase in world food production is needed before the end of this century if we are to avoid even more massive starvation than now exists. Most must come from the land, and from the present land area, since opening up new lands is expected to provide only about 30 per cent of this increase on a global basis. Acting against this, however, is the rapid loss of arable land to nonagricultural or forestry uses, or loss through abuse and mismanagement.

Soils also help control our global environment. Soils result from the interactions between water, air, the earth's surface and living organisms. As such they control the quality of both the water passing through and the air above them, and the quality and quantity of plants growing upon them. The global temperature regime, the ozone layer, atmospheric sulphur, nutrient mobility, supply and mobility of trace elements, and several more global concerns are all influenced by soils. Although soils normally benefit the environment, their ability to do so decreases, while the tendency to create problems increases, if soils deteriorate.

Earth is the only known planet with life on it. It is no accident that it is also the only planet we know of with soil ('Moon soil' is not soil — it is ground rock). Just as soil requires living organisms — all living organisms require soil.

The future of this province, of this continent, and of humanity, therefore, depends upon soils — not oil. Yet we willingly equate, at today's OPEC prices, an acre of productive soil in Alberta with five to 25 barrels of oil. The irony is that we look smugly at the Russians who sold Alaska for a few million dollars and the Indians who sold Manhattan island for a string of beads and a few gold coins. We may be well on the way to squandering our own futures, through misplaced priorities. For example, a medical research heritage fund of about $300 million has been established. Medical science will never cure starvation, nor will it find ways to control the quality of the air we breath, the water we drink, and the food we eat. On the other hand, a Farming for the Future Fund (a small part of which is available for soils research) which has been set up is in total less than the annual interest alone from the medical fund. Petrodollars can buy a lot of status quickly, but history will record it as prodigality of the worst sort if we disregard our only hope for the future during times of plenty.

Soil degradation is neither new nor unnatural — but its present rate is both. Soils are dynamic living entities. They continuously change with both destructive and constructive processes operating together. Our use of soils may affect both groups of processes or it may alter the balance between them. Since soils are open, dynamic systems, it is of little use to ask if a particular practice has affected a soil this year. What is essential is to know in what direction we have altered the balance between agrading (accumulation) and degrading processes.

There are several reasons why we allow soils to degrade. First is the idea that soils are static, or are magical buckets into which nasties may be placed and from which goodies are withdrawn. Out of this flows the idea that what worked well once will continue to be a desirable soil management practice.

The notions of muck, mystery and motherhood surrounding soils have done no end of harm. They have led to the general and erroneous conclusion that since soils contain everything but the kitchen sink and are such complex systems, they cannot be understood — therefore, one should not try. Conversely, associating soils wih motherhood has hindered objective study and management of soils.

In many institutions, soils are considered only insofar as they affect plants. Many agriculturists still prefer to ignore the effect of soils on crop and food quality. Foresters are peculiarly susceptible to the notion that the forest ends at the litter layer.

Environmentalists appear preoccupied with things that either are green or move. The average urbanite knows full well that food comes from the supermarket, that there are only two kinds of soil — black loam and clay — and that the former can be bought at the garden supply and the latter can't.

Further, government 'cheap food' policies have required that soils be ruthlessly mined for farmers to make a profit. Farmers, who as a group are probably more concerned about conserving soil than any other segment of society, are generally forced by these policies into jeopardizing or inefficiently mining the soil they would prefer to husband carefully for future generations.

Most of the readily mineable nutrients are gone from our soils. The next two decades will see either a fundamental change in the way societies and governments around the world view the importance of soil in food production and environmental control, or disasters of frightening magnitude.

I believe it will be the former. Evidence of this realization is already available from several parts of the world. We in Alberta, however, seem preoccupied by the bright light of black gold. Any stature this province may gain from petrodollars will be rapidly lost if we do not pay due attention to our only assurance of continued prosperity — our soils.

Dr. McGill is head of the University of Alberta's soil sciences department.

Jim Neaves

Why Farmers Worry

Careful land management can correct or reverse soil problems.

Bob Sarafinchan had to dig deep into both his pocket and his land to cure a production problem on the 194-hectare farm he took over from his father in 1970.

The farm, located about 3km southeast of Vegreville, 80km east of Edmonton, had been owned by his family since 1950 and was classed as a mixed operation, producing both grains and livestock.

"I decided to go into hog production in 1970 and seeded areas — that previously had grown hay — into barley which I needed for the pigs," he says.

"That's when I discovered something was wrong."

The 'something' was that some areas of the land produced only .09 tonnes per hectare of barley to .18 tonnes per hectare compared with the 1.79 tonnes per hectare produced on other areas of soil.

Investigation and consultation provided the answer: some of Sarafinchan's land was what is known as 'solonetzic soil' which is also called burn-out, blow-out or gumbo soil.

Experiments at the Vegreville federal research station indicated deep plowing could increase the problem soil's productivity.

Solonetzic soils are characterized by a tough hardpan, or impermeable subsurface, which severely restricts root and water penetration below the topsoil. The plowing, to a depth of up to 60cm compared with the normal 10 to 12cm, mixed the soil layers.

"I found that my problem areas had about one and a half inches (4cm) of topsoil, under which there was this hardpan layer about a foot deep, under which was sandy soil to a depth of 24 inches (60cm)," Sarafinchan says.

Government assistance was available in the form of a special deep-cutting plow and grants for fuel costs. Sarafinchan had to provide his own tractor to pull the new plow.

"We did about 10 acres (four hectares) the first year and it was almost a disaster because the two-wheel-drive, 110-horsepower tractor we used just was not powerful enough," he relates. "Both the tractor and the plow kept jumping about."

That was when he decided to dig deep into his pocket and purchase a 230-horsepower, four-wheel-drive machine that, as was proved later, had no trouble pulling the huge single-share plow.

Alberta Government Photo

"At one time my brother and I hooked up two tractors to the deep plow with a cable, and the plow went through that hardpan like butter."

The change in productivity was "almost instanteous and miraculous." After a year, barley yields climbed to the average for other areas of the farm.

But there was one interesting side-effect. "Weed seeds, particularly thistle, that had lain dormant for goodness knows how long suddenly germinated and, even today, some of them are still there."

Experts estimate the rejuvenated solonetzic soils have a life-span of 20 years. Frank Rensties, County of Minburn assistant agricultural fieldman who works out of Mannville, says the county's agricultural service board provided initial funds about 12 years ago to set up demonstration plots on deep-plowing solonetzic soil.

"We've found deep plowing is a real good way to handle these problem soils."

Solonetzic soils are scattered through about 5 million hectares extending from east of Edmonton to Brooks in a belt about 80km wide. They are also present in the Peace River, Chancellor, Clyde, Leduc, Coutts and Cardston regions.

Solonetzic soil is only one of the several Alberta soil problems. Others include acidity, salinity and wind and water erosion.

These problems can occur almost anywhere among six major soil types of the province's 64 million hectares. They range from the poor Gray Wooded soil in the north to the rich black soils of the Edmonton-Calgary corridor. Of the total, only about 11 million hectares are under crops, pasture or summerfallow while another 8.5 million hectares are classed as unimproved farmland such as woodlands. Acidity (low soil pH) problems are more prevalent in the northeastern area, and the Lethbridge region is prone to erosion and salinity.

Summerfallowing, the practice of alternating grain or other crops with a year in which the land is left uncultivated, is another bone of contention in the agricultural community.

Water erosion can be a powerful force of destruction (top).
Shelterbelts reduce wind, retain snow cover(below).

In use from the earliest days of farming in Alberta, it has always been valued as a cheap means of keeping moisture in the soil, thus also preventing erosion. An estimated one-third of Alberta's cultivated land lies fallow every year.

Farmers as well as agriculturists are divided in their views on the benefits of summerfallowing. While it undoubtedly retains moisture, there is now a suggestion that it may aggravate harmful nitrogen losses from the soil. Weed control has always been a problem in summerfallow, requiring either the application of herbicides or repeated cultivation, with resulting high fuel costs.

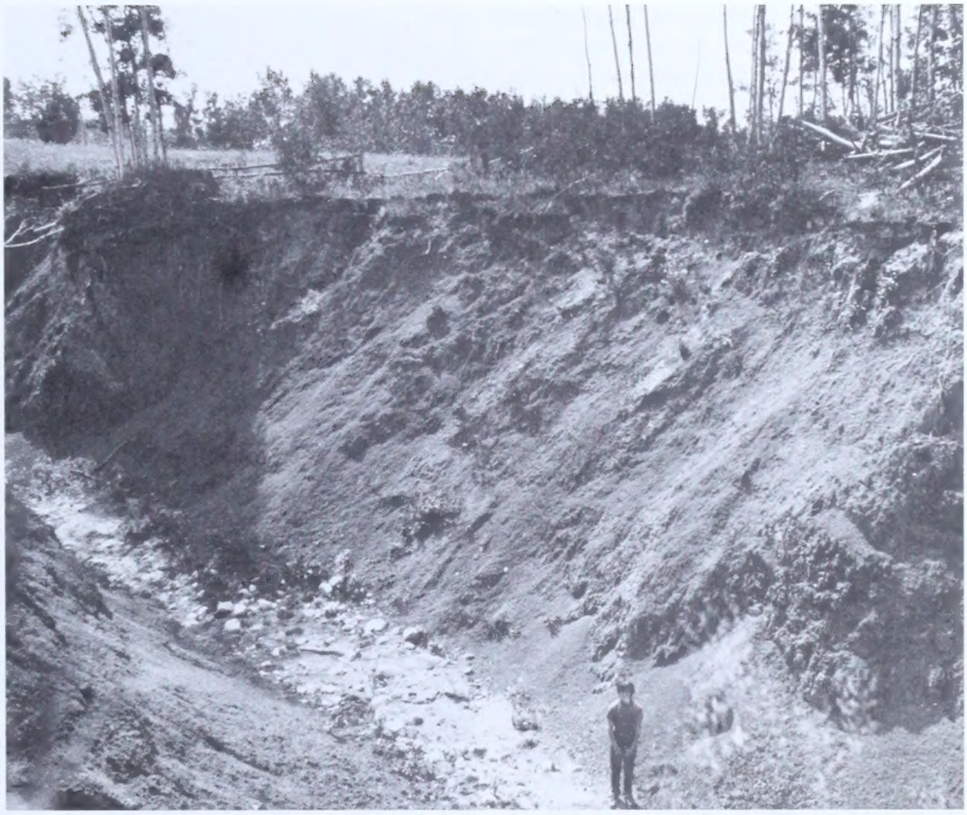
Perhaps most important, summerfallowing undeniably restricts the return of organic material to the soil. Even native grassland returns more plant matter than the fallow year of a wheat-fallow cycle. The small amounts which are reabsorbed are not given a chance to decompose naturally at a beneficially slow rate; instead, weed-control tillage knocks around the soil particles and increases the rate of decomposition, ultimately making less of the all-important organic matter available to the soil.

Balanced against this, however, is the simple need for soil moisture. Many farmers use summerfallow in the hope that a dryland field will store enough moisture over the fallow year to produce good yields the next season, regardless of how much topsoil may be blown away in the process.

One suggested solution is raising forage crops such as alfalfa, which fix nitrogen to their root systems, and return considerable vegetable matter to the soil: the more plant growth on an area of soil the healthier it is, runs the theory. But what's the point of all that alfalfa? Like other forage crops it can be difficult to market, and not every farmer keeps livestock to feed.

Erosion can result from a number of causes, but the best-known and most fearsomely dramatic of recent times was the wind erosion of the 1930s.

As long as native prairie survived, the extensive intertwined grass roots locked the soil in place. By the 1930s, however, farmers


Alberta Government Photo

Lauren Dale

Lauren Dale

had plowed under large areas of grasslands to plant grain. When strong winds came, the lighter soil particles lifted into the air, while heavier particles rolled across the surface into snow-like drifts. Topsoil hung overhead in a dense black cloud over whole districts, creating the 'dustbowl.'

Low precipitation and poor snow cover throughout the winter in recent years have presented a grave erosion hazard in parts of Southern Alberta, though not again on the scale of the 1930s.

John Hermans of Alberta Agriculture has been involved with research on erosion and solonetzic soil problems. He says the problem soils "have been there for many years but not recognized."

There has been a 'vast improvement,' he contends, in soil use during the last few years.

"We were not managing our soils back then as well as we are now."

Many soil management practices available to today's farmers can improve their crop yield while maintaining the health of their soil and even, in some cases, improving it.

Farmers can easily obtain information on their soils through an inexpensive test conducted by the agriculture department's laboratory in Edmonton. Control measures for wind and water erosion — which can be seen — have been standardized in the form of shelterbelts of trees and strip cropping to reduce wind erosion, seeding known waterways and growing cover crops to retard water erosion.

In areas of low soil pH (acidity) lime applications can combat poor growth; farmers can also grow crops such as flax and rye which are reasonably acid-tolerant.

Alberta Agriculture is planning a program to provide assistance to allow lime applications in the northwestern area. While lime is a major investment for a farmer, the beneficial effects of one application will last many years.

In southern Alberta, irrigation poses its own special problems. Salinity — often called white alkali soil — occurs in patches throughout the province, but is most prevalent in the south and east-central areas. The problem exists on both dryland and irrigated areas and can result from too much, not enough or even adequate moisture. Water, in excess of the amount needed by the crop, collects salts as it moves below the surface. When it meets an impermeable layer, it eventually discharges the salts to the surface producing characteristic white patches. Remedies can be effected but are usually costly, and there are no known 'chemical' cures for the problem.

Alberta Government Photo

Only about seven million hectares of arable land now remain for development in northern Alberta, and most of the soil is poor. Its productive capacity is limited for cereal and oilseed production, but it is suitable for grass and legume production.

Land is becoming more and more indispensable as population grows and the health of productive soil must be maintained. Almost any Alberta farmer will agree that proper soil management is imperative because "they're just not making it anymore."

Jim Neaves is a journalist living in Athabasca.

Muriel Stringer

Our Depleted Soils

Topsoil, organic matter and soil nutrients are easily lost — and costly to replace.

Provincial Archives of Alberta H Pollard Collection

In some parts of the world, one might well ask "Where have all the flowers gone?" In some parts of Alberta the soil itself is disappearing.

"Any disturbance of the land is going to cause a change in the soil," says Dr. Steven Pawluk of the department of soil science at the University of Alberta. "The question really is how much and what kind of change is acceptable. It's by no means easy to reach a decision on how you're going to manage a piece of land to ensure that the soil not only produces something you can use, but also that it stays productive over a long period."

In Alberta, two areas appear to be especially susceptible to soil depletion — the Peace River region, and the southern part of the province.

The Peace River problems are essentially those of water erosion, explains Dr. David Chanasyk, an assistant professor at the University of Alberta.

"Quite a few people seem to think of soil erosion in that part of Alberta in terms of loss of land along the municipal ditches, but the problem is a lot more widespread and serious than that. These ditches, in fact, break up the natural drainage patterns and carry off in their water soil that's been washed off the surface of agricultural land."

[illegible]

Dr. Steven Pawluk

The soils in the Peace River region tend to be fine-textured and this, with the long slopes found in much of the area, makes the ground particularly prone to water erosion.

"Snow melt is another important consideration," says Chanasyk. "In this part of the world, you can get a high concentration of snow melt over a very short period, and a lot of run-off taking topsoil with it. Right now, we're trying to find how often we might expect to get big snowfalls and heavy rains, and the effects these might have on soil depletion. But there haven't been very many studies of erosion done in Alberta. We've tended not to notice it or not to worry too much about it, partly because it's the sort of thing that doesn't happen overnight — it's a gradual process."

Dr. Marvin Nyborg, another of the soil researchers at the University of Alberta,

How much chemical treatment is enough — or too much?

Lauren Dale

emphasizes that soil depletion is by no means confined to the Peace River area.

He puts it bluntly, "As far as the rest of Alberta is concerned, it's just a question of degree of loss and a question of time before losses in soils become apparent."

Already the drier southeastern parts are suffering obvious wind erosion effects, and it appears that man is one of the culprits. Generally, wind erosion is looked on as a result of over-use of the land but in this instance under-utilization seems to be more of a problem.

Doug Penney of Alberta Agriculture pinpoints the practice of summerfallowing as a contributor to the disappearance of soil in water-short regions of Alberta.

"Summerfallowing means that the farmer won't put in a crop in some years in the hopes that while the land is lying fallow it will accumulate enough of a water reserve to carry a crop the following year. Typically, in southern Alberta you'll get wheat grown every second year, with the land in the fallow years either treated with a herbicide or given a minimum tillage to keep the weeds down. Doing this make economic sense to the farmer, at least in the short term, because he doesn't take into account the topsoil he's losing as a result of leaving the ground exposed to the wind during those summer months when it has little or no vegetation cover."

Even in winter, the climate in the southern part of the province plays a part in degrading the soil.

"Down there, you're in the chinook belt so the land can lose its snow cover two or three times in one winter. Not only does this cut down the amount of water there will be available after spring melt, it also means that the soil will be exposed to freezing temperatures and may be broken up so that it's pretty easily carried away in the next high wind."

Leaving 'trash' or mulch such as straw as a cover on the soil surface can help to retain water as well as to protect the soil from exposure to the wind. Minimum cultivation or disturbance of the ground in fallow years also cuts down on soil loss. Burning stubble, cautions Chanasyk despite widespread opposition, isn't necessarily a bad thing although in general anything that leaves the soil more-or-less open to the elements is not a good idea. Generalizing on the advantages or disadvantages of tillage can also be dangerous.

"It depends on the type of soil, the kind of tillage, the time of the year when tillage is done, and a large number of other factors. Under some conditions, tillage does encourage soil loss but with certain kinds of soil, there are ways of tilling that can help make the soil take up water and in this way reduce loss of the upper layers through erosion."

Andrew Vaughan

Doug Penney

Other agricultural practices, too, should be weighed for several considerations, not the least being economic.

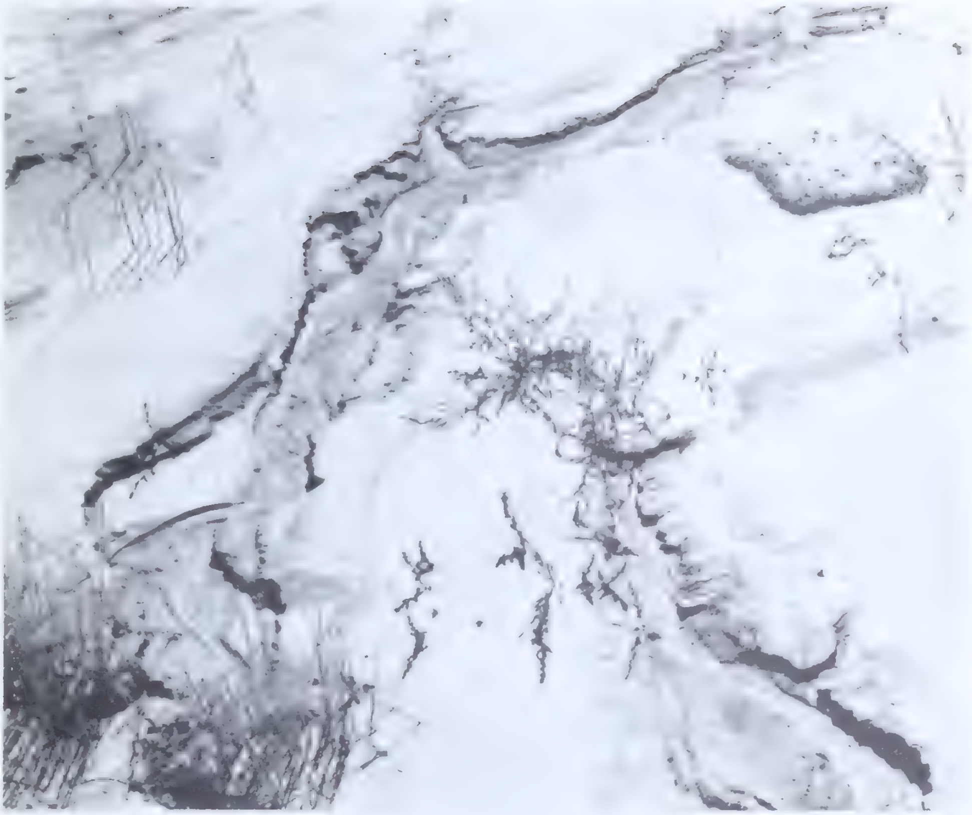
"When you're talking about loss of topsoil, you're really dealing with loss of organic matter, notably nitrogen," explains Nyborg. "It's true that continuous cropping, as opposed to letting the land lie fallow some years, will help to retain soil but you're growing twice as much and it isn't just more moisture that's needed — you have to add extra nitrogen fertilizer as well, at least for the first few years. Fertilizer isn't all that expensive right now but it won't always be all that cheap."

Addition of fertilizer can cause other problems such as the gradual acidification of the soil. Soil acidification from this and other sources can impair the productivity of the land, and is a serious form of depletion.

Nitrogen may be returned to the soil by natural rather than artificial means through the planting of crops such as alfalfa and other legumes, which can absorb nitrogen from the air and fix it in their roots. The nitrogen from the roots is released into the soil when the plant decays. Some researchers, however, doubt the feasibility of this method.

"Sure, you can get up to 100 pounds an acre (18kg per hectare) of nitrogen back into the soil this way," says Nyborg, "but what's the farmer going to do with all that alfalfa? There's just so much he can use for animal feed."

Some crops, while perhaps a better bet economically, tend to aggravate soil loss, partly because of planting practices and partly



Lauren Dale

because of the normal way in which they are harvested. Planting of sugar beets and vegetables is usually in rows which can turn to gutters carrying off topsoil, especially if the rows run lengthwise rather than across a long slope. And many vegetable crops are harvested by methods leaving no residue or mulch behind. Continuous culture of such crops, when water is lacking, is likely to lead to wind erosion.

In trying to find solutions to the depletion of soils in Alberta, it is futile to look for a single or a simple answer, reckons Dr. Bill McGill, head of the soil sciences department at the University of Alberta. Techniques used successfully elsewhere may have some value here, but should be examined critically before being applied to any situation in Alberta.

Terracing of slopes, for example, is not a likely solution to water erosion.

"We'd have to alter our whole style of agriculture if we were to make that work. For one thing, tilling terraced land is a very different business from going over the soil with the kind of machinery we use nowadays."

Other methods of preventing soil loss are, however, more promising. Snow management and retention of heavier snow cover through the planting of grass strips has been used to good effect in Montana and might be helpful in improving moisture levels in some parts of Alberta. Leaving swathes of straw standing by cutting only the heads of grain could also help provide protection from the wind during subsequent fallow periods. Planted wind breaks can be another effective way to provide shelter from predatory breezes.

"But as far as water erosion is concerned, it isn't a lack of technology so much as a lack of willingness to use it that's at the core of our problems," McGill maintains.

The ready availability of fertilizers has been another factor, according to Penney, which has tended to encourage agricultural practices leading to nutrient depletion and has allowed more soil loss to take place than would otherwise have been tolerated.

"It isn't as bad as 'land mining' — that's taking nutrients from the soil via crops and putting nothing back. But it does give a false sense of security if you feel that putting on fertilizer is going to compensate for the loss of large amounts of organic material."

Organic farming, however, doesn't seem to be the answer. Based on recycling of nutrients directly from organic material, this style of farming is not a large-scale proposition simply because it is uneconomical to attempt to return directly to the soil nutrients lost through the harvesting of crops which are exported all over the world.

How soil can efficiently and economically be saved in Alberta may well become an even more pressing concern in the near future. Interest in soil conservation in the province has been growing since the mid-1970s, and financial constraints are fostering better land management. Dirt, it seems, is no longer cheap and is becoming less so.

As McGill puts it, "Seed, fertilizers, herbicides, and farm equipment are all costing more, so there's a growing incentive for us to keep the soil as productive as possible."

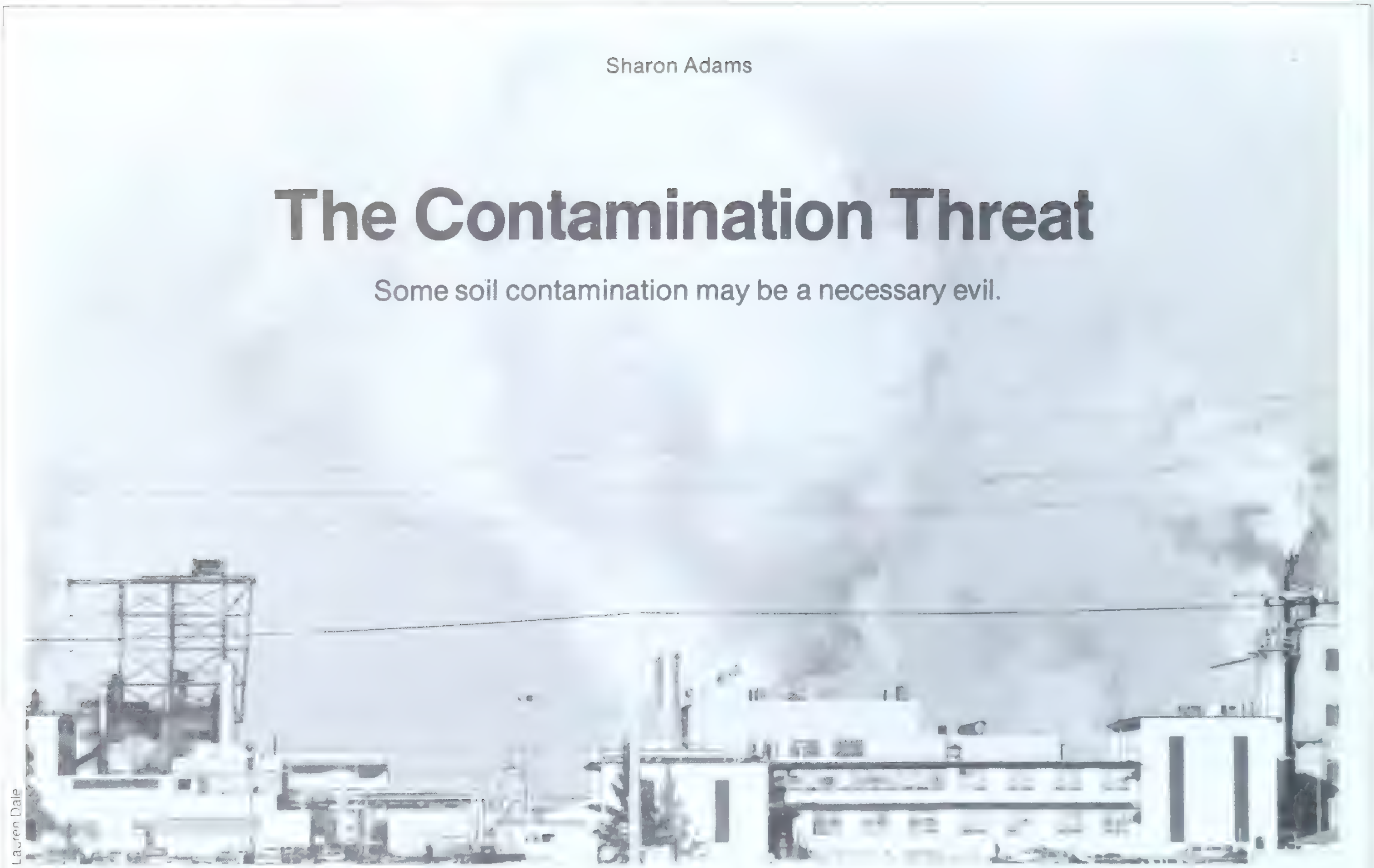
Muriel Stringer is an Edmonton freelance writer

Alberta Government Photo

Sharon Adams

The Contamination Threat

Some soil contamination may be a necessary evil.



Lauren Dale

Alberta has been blessed, as well as cursed, by the lack of industrial development. Because there are few pollutant-belching plants and no large consignments of chemical by-products to dispose of, this province has little problem with soil contamination compared to our more industrialized neighbors.

Soil contamination can be serious, though, even here. Chemicals and heavy metals contaminating the soil can get into the ground water supply or be taken up by plants and enter the human food chain. The result can be poisoning with unusual symptoms which may go unrecognized by doctors, or a gradual accumulation in the body of a substance which may or may not prove harmless over a lifetime.

Although Alberta has a relatively clean slate, efforts are being made to improve the record. Each industry is being contacted to ensure it properly and safely disposes of hazardous wastes. Accidental spills are monitored and cleaned up. Researchers are beginning to think about the cumulative effects of extremely low-level contamination over a long period of time.

Dr. M.J. Dudas, a soil scientist with the University of Alberta, says "in a relative sense, we are well off. We have only small inputs; nothing to worry about in the short term."

But he says one long-range worry is traces of heavy metals that farmers spread on their land every year in fertilizers and pesticides.

"It is exceedingly trivial each year, but in the long term, perhaps 100 years, it could be significant. Eventually, it gets into the human body, barely above natural levels, but over a lifetime (of accumulation) it may have some effect."

Andrew Vaughan

Dr. M.J. Dudas

Because heavy metal poisoning is unusual in Alberta, its symptoms may go undiagnosed. "Heavy metal poisoning is often diagnosed as ageing," Dudas says. Cadmium poisoning, which Albertans may be exposed to, mimics the symptoms of arthritis, for instance, and victims may complain of sore joints and other problems often experienced by the elderly.

Though people living near an industry might be expected to exhibit signs of such poisoning, it is by no means limited to them alone. Agricultural practices can result in heavy metals or chemicals being taken into plants or water supply consumed by humans or by the animals which they eat, thus entering the food chain.

Sewage sludge used as fertilizer is one way heavy metals enter the food chain. Dave Graveland of Alberta Environment's technical development branch in Lethbridge is involved in monitoring sewage sludge application which are done 'on a large scale' in Alberta.

Sewage disposal is a looming problem, he believes. While about 420 smaller communities can safely dispose of sewage in lagoons, where the material is biologically broken down over time *(see Environment Views Vol. 3, No. 1)*, such a method is impractical for large population centres which must rely on sewage treatment. Solids and liquids are separated in the 15 to 20

HERE'S YOUR DINNER! LOVELY CHROME TURKEY IN ZINC GRAVY; MASHED LEAD; NICKEL-PLATED PEAS; HOME-BAKED CADMIUM BREAD; AND FOR DESSERT, NITROGEN-GLAZED DONUTS WITH ACID-RAIN COFFEE. YUMMY!

treatment plants and the solids, about 40 tonnes per day per smaller city with Edmonton and Calgary contributing 300 to 400 tonnes, are spread on farmlands.

Graveland says between 280 and 400 hectares near Calgary and 'a few hundred acres' near Edmonton are treated with sewage sludge each year. Smaller centres spread sludge over a smaller area in keeping with the lesser amount produced from their treatment plants.

"Nobody argues with the value of sewage sludge as a fertilizer," Graveland says, "but we have to look at other things as well."

Those 'other things' mentioned are heavy metals and chemical contamination. Each city's sludge is unique: Edmonton's contains more chromium, Calgary's more lead. Graveland and his branch work out maximum loading factors for each substance. Calgary's sludge, he says, can be applied to a particular field two to four times because of the lead content, with applications separated by a few years because of nitorgen loading, which can contaminate ground water.

Dudas and Dr. Steven Pawluk of the University of Alberta, in a 1974 study, traced heavy metals from application on fields to entry into the human food chain. Between 80 and 160 tonnes per hectare of Edmonton sewage sludge was spread on clay loam subsequently used for a lettuce crop. The harvested samples, when analyzed, were shown to be "highly enriched in several metal elements" compared to control samples. Concentrations of lead, copper, zinc, cadmium, chromium and nickel were "as much as 16-48 times higher" in sewage-sludge treated samples, they reported.

Though the researchers noted a 'significant' increase in yield due to the nitrogen content of the sludge, they concluded "it is obvious that a number of hazardous trace elements occur in high concentrations in . . . the samples. Some of these trace elements are readily taken up by plants and could constitute a hazard to humans."

Dudas and Pawluk also noted that the "tolerable intake level (of cadmium) could be exceeded when an individual consumes the equivalent of 61 to 76 grams of dried lettuce grown on soil treated with Edmonton sewage sludge." Other studies mentioned in their report indicate this element is "readily taken up by common vegetable crops," so lettuce isn't the only vegetable affected.

The researchers also noted that heavy or continued application of sewage sludges to a particular land area would result in "a build-up of trace elements," but "the long-term effects of such a build-up remain unknown."

Guidelines for sewage sludge application, listing loading factors for each identified hazardous substance, are now being drawn up, but Graveland predicts "we will eventually run out of land" on which to spread the stuff. Disposal, he says, is going to be "a large problem, an expensive part of treatment. But it's being ignored to some extent."

Graveland also worries about other agricultural practices, for while "we can control the amount (of trace elements) put on in the sludge, there are no restrictions on fertilizers" which contain elements such as phosphate and cadmium, which can build up in the soil. He also worries about manure from livestock operations which causes a build-up of nitrogen in the soil which can enter ground water supplies and cause contamination.

University of Alberta soil scientist Dr. Marvin Nyborg has studied the effects to the soil of continued fertilizer application.

"It slowly lowers the pH (or acidifies) the soil over 10 or 20 or 30 years," he says. Though acidification is slow, "when it happens it's serious." Alfalfa is the first Alberta crop to succumb, but grain crops can be affected by acid soils as well. To return to pH levels to normal, soil must be treated with lime — about two or three tonnes per acre, an expensive proposition.

"Nitrogen is the worst culprit for acidification," Nyborg says, "but you've got to remember crop yields would be cut by half without fertilizers." Nitrogen contamination may be a necessary evil if livelihoods are to be maintained.

Soils can also be affected by lead contamination from nearby highways. Dudas' research has showed roadside soils are contaminated with lead in proportion to the distance from the roadway, depth of soil and number of vehicles passing per day.

His research confirms results of a Canadian study by Matt K. John for the federal department of agriculture, in which 700 samples from British Columbia agricultural soil were analyzed for lead content. Aside from contamination from a battery smelter, he reported "the major sources of soil contamination with lead are combustion products of leaded gasoline, lead arsenate pesticides, phosphate fertilizers and wastes from metal smelting." He reported that in 1965 the annual motor vehicle exhaust in North America was 240,000 tonnes.

But Dudas says the future for lessening of roadside lead contamination is bright. Contamination has been cut by the advent of low-lead and non-leaded fuels and perhaps this form of pollution will be entirely eliminated by development of alternate fuels.

"There are no long-term studies (because of this), and there are a lot more immediate problems," he says. "There's no question that farmers shouldn't be cutting the grass along highways to be fed to their stock."

Rob Pritchard, with Alberta Environment's waste management branch, has the responsibility of making sure accidental spills which could contaminate the soil are cleaned up.

"When somebody spills something," he says, "we insist they repair the damage. If the soil is contaminated, then they must either add chemicals to neutralize it, or excavate the soil, remove the contaminated soil to an approved disposal site and bring in fresh soil, then reseed the area."

The Energy Resources Conservation Board, he says, has responsibility over clean-up up of biodegradeable pipeline spills of crude oil, but the waste management branch watches over the most common spills of diesel oil, gasoline and elemental sulphur. Gasoline, transported daily in 5,000-gallon tanker trucks, poses the smallest clean-up problem because sometimes it is trapped and crews are simply able to suck it up and haul it away. When that isn't possible, most of it is dispersed in the air or sanitized in the soil so routine tilling of the soil aerates it. With reseeding to rejuvenate the plants killed on site, clean-up is completed.

Lauren Dale

While municipal landsites are a concern in themselves *(see Environment Views Vol. 2., No. 6)*, of particular concern are those companies which provide for themselves. On-site disposal practices range from excellent to extremely poor.

Now the branch is doing a "plant by plant inventory of waste management through the entire province."

Though it will take time, says Pritchard, when it's accomplished Alberta will be assured every industry knows the rules and abides by them.

But that still won't answer the long-term question — a question that can only be resolved through research. No one is positive how any one chemical or heavy metal will react with different soils, or at what rate. The amount of water in the area, the consistency of the soil and the type of pollutant all are factors. In addition, it is known that some contaminants are dispersed and thereby diluted in the soil, that others can be diluted through evaporation and still others "purified" within the soil when soil particles absorb contaminants.

"The situation in Alberta is not as serious as in some heavily populated areas with industrial activity," says Dudas, "however, our slate is not clean.

"We do not have all the answers concerning heavy metal pollution and problems in Alberta. Very little has been done in this regard, mainly because the government does not place much emphasis on such research, and qualified personnel are limited."

Sharon Adams is a Calgary journalist.

David May

Alberta's Changing Pattern of Soil Use

100 years striving to make efficient use of available land.

Provincial Archives of Alberta E. Brown Collection

Captain John Palliser was an adventurer, explorer and hunter, a well-connected young Irishman whose main ambition in life, says historian Hugh Dempsey, was "to pick up his rifle and wander into unfamiliar lands for the sheer enjoyment of his sport."

Although no scientist, Palliser knew a potential desert when he saw one, from personal experience and from the tales of his five brothers — one sailed the China Seas, another disappeared on the Franklin Polar expedition, two hunted in Ceylon, and the other travelled the Australian outback in the early 1800's.

His name was to be immortalized in the arid Palliser Triangle, its apex reaching to the 52nd parallel (close to Saskatoon), its base running along the international border from Lethbridge in the west to Brandon in the east, an area described by Palliser's fellow 1858 expedition member Dr. James Hector as containing "many varieites of land, and some limited areas that are really very good; but, on the whole, it must be described as deficient in wood, water and grass."

Palliser's report remained unpublished until 1863, and the main map of his travels until 1865. The original cartographer wanted more time to check Palliser's findings against earlier data on the region, but impatient Colonial Office officials in London fired him and gave the job to another cartographer.

By that time, political forces were at work in Eastern Canada, forces that preferred the more optimistic words of Professor Henry Youle Hind, chemist, geologist and leader of the 1857 exploration of Western Canada, commissioned by the government of the Province of Canada.

"This continuous belt can be settled and cultivated from a few miles west of the Lake of the Woods," wrote Hind, "to the passes of the Rocky Mountains, and any line of communication, whether by waggon road or railroad passing through it, will eventually enjoy the great advantage of being fed by an agricultural population from one extremity to the other."

By 1881, Palliser's dryland warnings were all but forgotten in a flood of westward immigration, spurred by the advance of the Canadian Pacific Railroad, the disappearance of the plains buffalo and the disintegration of the Plains Indian society as a challenge to white settlers.

In 1881 as an incentive to those settlers the Canadian government offered leases of up to 100,000 acres (40,485 hectares) of Crown land at one cent an acre. In that same year the CPR line probed as far west as Brandon, the eastern tip of Palliser's Triangle. Soon after, CPR tracks ran straight

Provincial Archives of Alberta, H Pollard Collecti

through the Triangle's cactus-dotted wastes.

Losses through farm abandonment began as early as 1886 and were to continue for the next 50 years. It was "land that should have ben left to grow cactus," in the words of Dr. J.G. MacGregor. Treeless, bushless, devoid of fuel, in good years it produced only .34 tonnes per hectare.

"The government of the 80s and their staff probably didn't include a single member of that of 1858," writes Major Douglas Stuart grimly in his book, "Our Creeping Desert: Its cause and Its cure." "And likely there was not a single dry soil expert on Parliament Hill."

But it was the depression years that took the greatest toll on these dryland farmers. Through the late 1920s wind erosion swept away overtilled topsoil by the thousands of tonnes. The 1931 Census listed 6,000 farms as abandoned or deserted, including almost 243,000 hectares of improved land.

From the dustbowl disaster emerged two positive improvements in the way man has subsequently used the soil in this part of the world. First, the provincial government began an inspection system to ensure that at least 50 per cent of a holding was suitable for cultivation before allowing further settlement.

Alberta Government Photo

The other advance was in technology, through the work of Charles Noble of Nobleford, north of Lethbridge. Working with federal government researchers Noble developed a plow blade that would leave crop residue on the soil surface, preserving precious moisture for future crops, and a seed drill that could penetrate deeper than the conventional type.

"Dryland agriculture has now developed techniques that simply couldn't have been envisaged by Palliser," says Adolph Goettel, head of Alberta Agriculture's soils branch and the province's representative to the Canada Committee on Land Resource Services. Those Canadian-developed techniques are now being used successfully as far afield as India.

If researchers seem less worried about the chances of another dustbowl in the pro-

The railroad opened southern Alberta for farming (left).
Not every soil supports profitable agriculture (bottom left).

vince's south, they are far from content with non-agricultural encroachments onto our best food-producing soils.

"If society wants to keep the price of food low then it must be prepared to reserve the good agricultural lands for food production," says "Land Use and Agriculture" a pamphlet produced in 1979 by the Alberta Institute of Agrologists. "If this does not happen, then both increased cost of production on poorer soils and the inflation of land prices in the better areas will drive up the cost of food."

The country acreage is the biggest single culprit in the permanent removal of prime agricultural land from productivity. Some 60 per cent of Canada's prime lands are within 80km of our major metropolitan centres. For too long, says Dr. Julian Dumanski, head of land use and evaluation with Agriculture Canada in Ottawa, these critical lands have been looked upon as a 'reserve' for urban expansion. In his view, all Canadians have to change their attitude "from exploitation to husbandry — and be prepared to accept the coincident cost."

Lauren Dale

But while the city dweller saves for his place in the country 'to get away from it all,' government planners and policy makers look for ways to get the most efficient use of available land.

In forestry circles, for example, shortages of wood pulp and good saw timber are a real concern. Yet, as Dr. Percy Sims head of terrestrial systems research with Alberta Environment says, "we don't know much about the native vegetation" of Alberta. When it comes to reclamation of a clearcut area "nobody could tell you exactly what fertilizer to put on it" to guarantee new growth, says Sims.

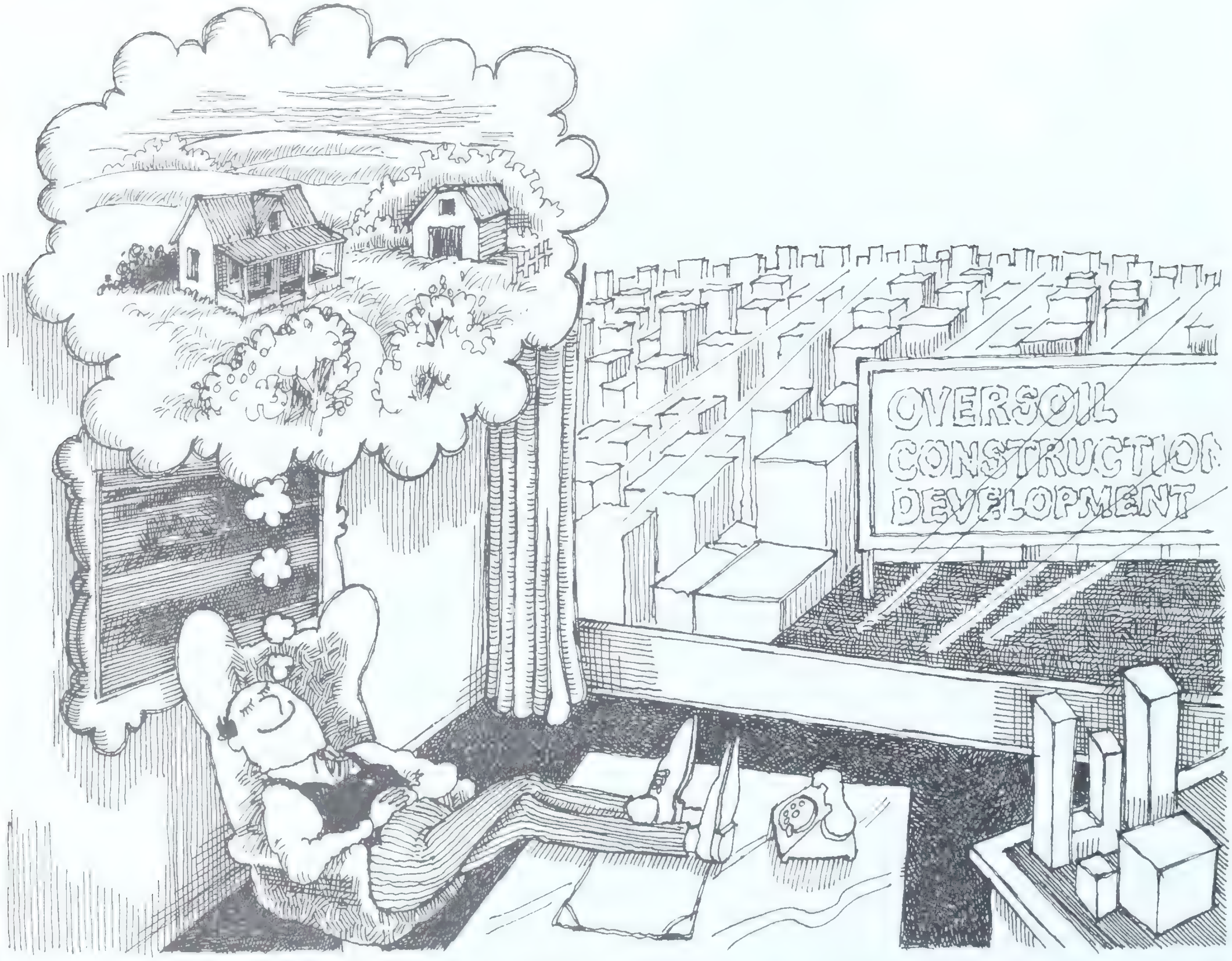
The need for answers — soon — becomes apparent in a complex development area like the Fort McMurray tarsands. There, reclamation work will include revegetation around 2,850 hectares of tailings ponds bounded by dykes more than 100 metres high, and reconstruction of soil in strip-mined areas.

"There is a lack of scientific knowledge

Andrew Vaughan

Adolph Goettel

Dr. Percy Sims



about our northern lands," says Dr. Larry Turchenek, soils scientist with the Alberta Research Council.

Some 16 million hectares of the north are covered by organic soils with a heavy peat content. What happens when industrial pollutants come in contact with such soils?

"There are two hypotheses," he says. "One is that the soil is already too acidic for acid rain to affect it. The other is that organic soils are a 'sink' for certain types of pollutants."

At this point, however, scientists don't have enough data about the chemical properties of peat moss. "The northern wetlands should have a high priority as far as pollutants are concerned," says ARC researcher Turchenek.

David May is an Edmonton freelance writer.

Lauren Dale

Jack Spearman

Beneath the Forest

It's time to develop our own studies of forest soils.

Alberta Government Photo

The forests of Alberta are one of the province's greatest natural resources. They cover two-thirds of the area, provide lumber for thousands of new homes, and are the source of paper on which industry and government run. When left standing, they form a sylvan recreation setting that brings millions of tourist dollars into the province.

Yet beneath this resource lies one even more basic — the soil in which the trees grow. According to forest soil scientists, few people appreciate that fact, which hinders better forest management.

Alberta was settled by men and women of the soil — farmers and ranchers — so it's not surprising that most soils research is agricultural, and aimed at increasing food production.

Research is lacking, by comparison, for forest soils, though forestry is an economic mainstay of the country. Only a handful of forest soil scientists work in Alberta, mainly with the University of Alberta and the two senior levels of government, to carry out research towards better forest management. Experts agree that research is biased towards agricultural soils, and that even basic research into forest soils has gone lacking.

Dr. Ivor Edwards, a soil chemist with the Canadian Forestry Service in Edmonton, explains it this way.

Canadians have always seen the forests stretching to the horizon. When one area is harvested, there's always another batch of trees just over the next hill ready for the axe blade. Soils research that would contribute to better forest management just didn't make sense when the supply of trees seemed infinite.

According to Dr. Don Pluth, an assistant professor in the soil sciences department at the University of Alberta, this is a "widely held but false opinion by lay people."

He notes that in the United States, with smaller tracts of forests and greater population pressures, research into forest soils is more advanced. Most of the basic research is complete and applied research is well under way. In the Pacific northwest, for example, scientists are looking at nitrogen as a fertilizer while in the southern states, drainage of soils is under examination.

Pluth explained that in the United States, agricultural schools are set up by statute, and money for forest soils research is available on a continuing basis. "There is not an equivalent legislative mechanism in Canada . . . that source of funding is simply not available."

Pluth and Edwards agree that forests in the U.S. are better managed. Pluth notes that in the states, the 'turnaround' period for a forest — the time between cuttings — is about 35 years.

In Canada, climate conditions are more severe and tree species differ. Here turnaround in a forest takes 75 to 100 years, a figure that could be reduced if more were known about forest soils.

"After the Americans do research . . . they put their findings into practice," said Pluth. "Traditionally, they have had a much higher intensity of forest management. But in Canada, we've traditionally had low-intensity management."

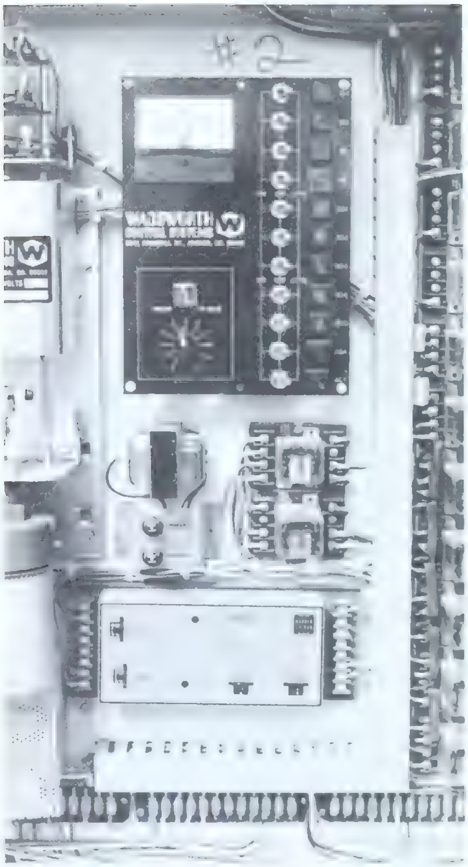
Edwards says many Canadians assume that American research can simply be moved north and applied in Canada and Alberta. "But this is nonsense," he says. "We have to develop our own programs for our own forests."

One of the basic differences between American and Alberta forests is temperature.

Canadian researchers, for example, do not know what effect temperature has on forest soils and how that relationship affects the growth of a tree, says Edwards.

Spring comes later in Alberta so the soil takes longer to warm, he explains. But when temperatures begin to drop again in the autumn, soils are still warm and nutrient and moisture uptake through a tree's root

Andrew Vaughan



Andrew Vaughan

system is at its prime. Meanwhile, the declining temperatures are a signal to the rest of the tree to enter winter dormancy.

"If we understood this process better, we could develop a system of understanding these micro-organisms . . . of how to get more growth efficiency at lower temperatures and how to get a tree to put on more dry matter (needles and leaves)," adds Edwards.

In Alberta, one of the major research question marks attaches to reseeding and fertilization. Some research is conducted when seedlings are in the nursery, says Edwards, "but once they're planted, they're just left there."

Other soil scientists point out trees need a tremendous amount of water to grow to maturity. Agriculture-oriented soil scientists have helped development of drought-resistant wheat strains and dryland farming techniques. "But when we plant a tree, we aren't even sure if it'll be drought resistant," says Edwards.

Virtually no research, he says, has been done in Western Canada on forest fertilization. For example, scientists know that in leaf and needle litter or cover, there is a good supply of nitrogen, "but what we don't know is how or if it becomes available to trees."

American researchers are conducting sophisticated experiments in aerial spraying as well as less exotic fertilization methods, such as thinning forests to expose leaf cover to sunlight and thus promote quicker decomposition.

Lauren Dale

Lauren Dale

Andrew Vaughan

"But I don't see anything like that here," he says. "I guess in Canada we assume the trees will always be here. I have heard nobody here say that perhaps we could help a tree along with some fertilization."

Once basic research on forest fertilization is done, the next step would be to investigate the flow of nutrients from soil into a tree. "We don't know what happens two, three and four years after fertilizing, whether it's best to apply one large dose and hope it lasts several years, or whether we should apply three small doses over as many years."

Edwards sees few signs that attitudes are changing about forest soils research. And until they do, Canadian and Alberta scientists will continue to have large blanks in their basic research libraries.

Pluth is somewhat more optimistic, saying that awareness of forest soils is now at 'an early stage.' He says recognition of the importance of reforestation is growing and that as it does, so will recognition of a need for research into forest soils. "The lack of reforestation efforts can be attributed, in some cases, to lack of soil management. People are beginning to understand that now," he says.

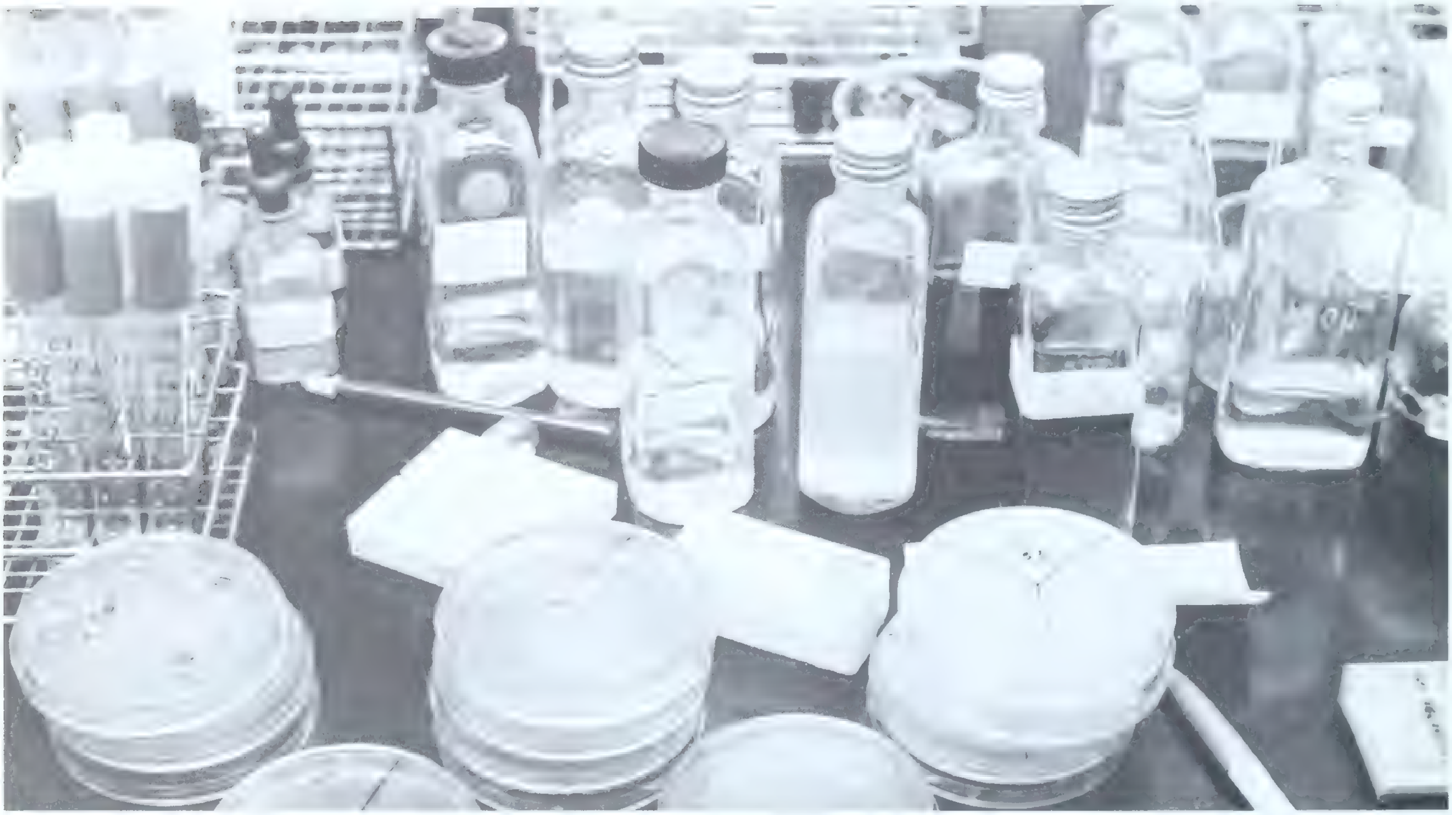
"It has taken a long, long time for the tide to turn. But it is turning. People realize that there won't always be another forest over the hill and that we've got to better manage the forests we now have."

Jack Spearman is a journalist in Calgary

David May

Researching a Non-Renewable Resource

A shopping list of immediate and serious soil problems.



Lauren Dale

An hour's drive southwest of Edmonton lie eight hectares of land whose history symbolizes much of the plight of soils research in Alberta.

The Breton Plots were established by the University of Alberta in 1930, at a time when climatic conditions and poor land management combined to send Western Canadian agriculture into a tailspin. The plots — on the Gray Wooded soil that makes up 80 per cent of Alberta's potentially arable land — are internationally known, and represent a 50-year-old living textbook on soils and their management in the western prairies.

But in 1978 the Battle of Breton was on. Tight budgets and inflation threatened to turn the plots back under the plow, wiping out five decades of data on plants and soils. "We fought hard to maintain them," says Dr. Bill McGill, head of soils sciences at the University of Alberta since 1978. Now he's cautiously optimistic. "We'd hit rock bottom," says McGill. "And we're on the way up again."

Researchers from the U of A have collected 3,000 samples from the Breton Plots since 1978. When fully analysed — a process that could take until 1983 — these samples will provide a unique series of case studies of land management, spread over half a century. "Now we can reap the benefits," says McGill. "The first 50 years were the toughest."

Time is decidedly not on the soil scientist's side. His work, like that of all scientific disciplines, goes on under the motto of "publish or perish." And if he works in a publicly-funded research centre, he's also dangling from purse-strings that have grown more slender since the mid-60s. Long-term funding for research fell into disfavor about 15 years ago. As one senior researcher puts it wryly: "Government seems to prefer its projects to be four years long. I can't understand why."

Mother Nature, however, doesn't timetable herself according to the electoral needs of the democratic system. Studying the effects of pollutants on vegetation around Fort McMurray, or the path of saline material through southern Alberta fields, can require a decade or more of study.

"Give me a magic wand," says Dr. Percy Sims, head of terrestrial systems research at Alberta Environment, "And I would use it to get the answers people want — now."

Some research chiefs, however, see tighter budgets as Darwinian evolution — ensuring survival of the fittest — at work in the scientific world. Canada may be spending 'a pretty small amount' on soil research, concedes Dr. Don Mackay, head of the federal

research station at Lethbridge, "But we are more efficient than we were 25 years ago . . . the best projects get the money."

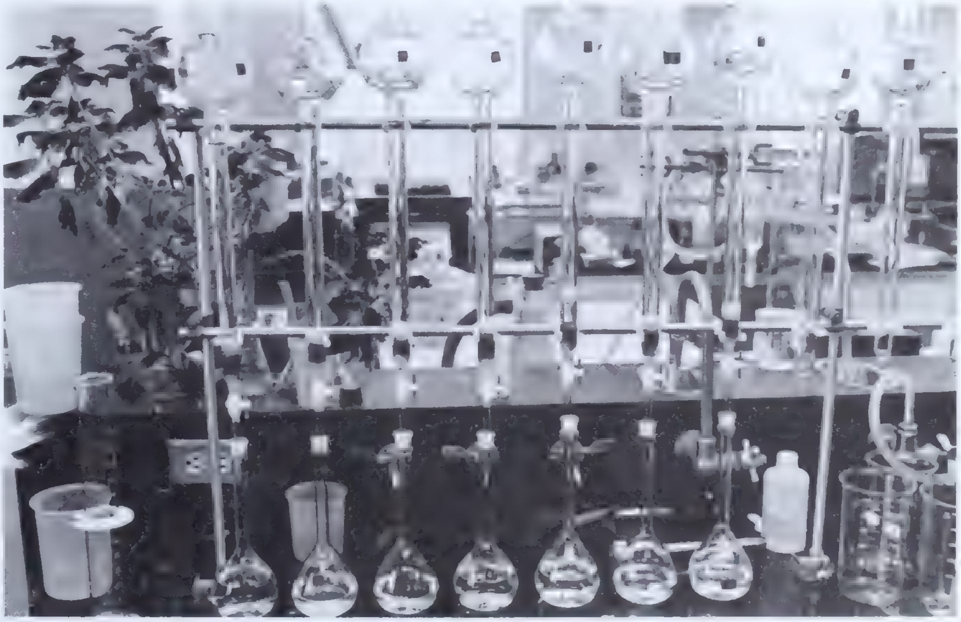
Historically, soils research in Alberta has been descriptive in nature, listing soil availability and depth through soil surveys. The surveys began in the 1920s, continued through to the 1940s when aerial mapping of the province was completed, and were supplemented soon after by helicopter surveys of forest resources in the northern half of the province.

While this aspect of research is still in need of updating, especially in the Edmonton-Calgary corridor region and in potential irrigation areas, the past five years have seen a gradual shift of emphasis towards a more dynamic approach to soils as part of the global environment. Soil mechanisms are increasingly the subject of study: the way in which soils supply the nutrients to plants, the effects of summerfallow on soil moisture, how pollutants travel through a forest, how man can build a soil from zero to reclaim a strip-mined area. These are just some of the research topics currently under study by federal and provincial scientists, in locations ranging from the ranchlands of the southwest to the forests of the north.

"Research is needed that recognizes soil as a dynamic system and as part of a global environment," agrees U of A's McGill, "but we must also recognize immediate and serious problems that have to be solved."

The shopping list of immediate and serious problems includes increasing salinization of soils (especially in southern Alberta), effects of sulphur dioxide on vegetation around industrial plants, the impact of fertilizers on soil quality, wind erosion (southern Alberta) and water erosion (Peace River country) and acidification of the province's soils. The Alberta Soils Advisory Committee which reports to the Canada Committee on Land Resource Services is currently hammering out these topics, to identify research needs and the extent of funding they require.

"There's a finite amount of agricultural land," says Doug Penney, head of soil fertility with Alberta Agriculture. "We must deve-



Lauren Date

Lauren Dale

lop the attitude that it's a non-renewable resource. But whether that attidue becomes strong enough soon enough is another matter."

One way of strengthening the idea is through more and better research, carried out by well-trained minds. In the field of soils research that means a PhD and at least five or six years' experience. Such people do exist, say the researchers, but the private sector's larger salaries tend to woo away from government projects. And within government research ranks, gaps left can take a long time to fill. Finding a qualified crop yield expert took Agriculture Canada in Edmonton a year. In one provincial government department, three senior research positions have been open for six months.

Meanwhile, pressure is on for soils scientists to increase Alberta's food producing capability. In 1980, the Canadian Wheat Board announced its plans for a 50 per cent increase in wheat production within the next decade. Three possible avenues could meet the increased demand: open up new lands, increase production on existing lands, or persuade Alberta farmers to change their ways and release some of the 10 million hectares left in summerfallow each year.

But "the idea of a vast cropland reserve in Canada may be more of a myth than a reality," warns federal government soils expert Dr. Julian Dumanski in a recent magazine article on Canada's agricultural land resource. While some scientists argue about the applicability of the 10-year-old Canadian Land Inventory, one incontrovertable fact remains. Only a tiny percentage of Alberta's arable land can be considered Class One (that is, with no climatic limitations) and most of this land is close to the growing cities. Canadian losses of such top-quality soils during the decade from 1966 to 1976 amounted to 1.2 million hectares. And while 1.6 million new hectares were opened up — most of them in the West — their biologic production potential wasn't enough to offset the losses elsewhere, claims Dumanski.

The current state of soils research doesn't supply the figures necessary to calculate productivity potential, confirms Dr. Wayne Pettapiece, head of the Alberta Soil Survey. "Right now we can't tell people what the yield would be, given top management (of the land)."

Increasing productivity has its problems too. It's been estimated that in the 80 to 90 years since the white man began to farm the west that 50 per cent of the soil's nitrogen has been lost already. Some of this loss was inevitable (the land had never been farmed before, so nitrogen content would initially have been very high.) But the total percentage loss is still a worry to scientists, many of whom are on the track of the way to fix nitrogen for plant growth. At Agriculture Canada's Beaverlodge research station, Dr. Wendell Rice has produced a new innoculant strain of alfalfa that has a 50 per cent increase in yield and will not winterkill.

The third option, that of reducing the number of summerfallow acres, is a tantalizing one. But it's also political dynamite. Scientists are beginning to suspect that summerfallowing — a technique developed almost by accident at Indian Head, Saskatchewan in the late 1880s — may in fact be the culprit in nitrogen losses from the soil. ("It's like opening a door to a furnace," is how one scientist describes it. "It doesn't give the soil a rest, as traditional theory would have us believe.")

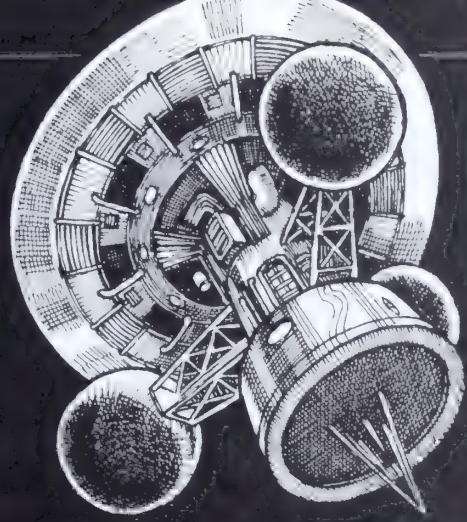
From the farmer's point of view, however, summerfallowing, by acting as a minimal-cost water conserver represents one of the few dependable hedges he has against the many climatic risks inherent in his livelihood. With almost one-third of the province's total farmland lying fallow each year, Alberta's soil scientists could have an uphill battle on their hands if they decide it's necessary to reshape the thinking of the farming world on this technique.

David May is an Edmonton freelance writer.

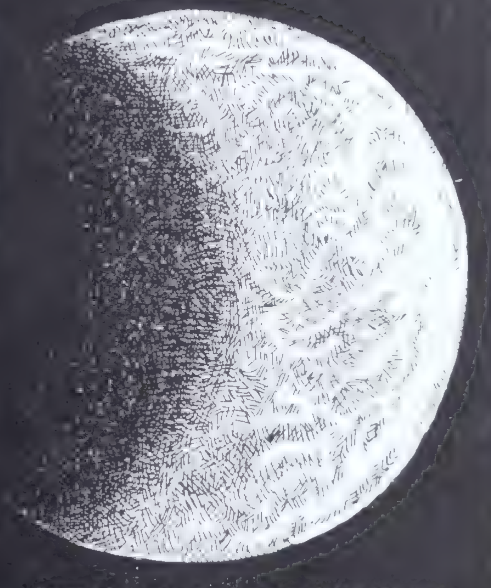
David May

The View from 900km

An aerial watchdog guards against soil 'wear and tear.'



Lauren Dale



From 900 kilometres above the Earth, the eyes of Icarus are watching the fields of Alberta.

Icarus — the name comes from the legendary aviator of ancient Greece — stands for Interactive Computer for Applied Resource Utilization Studies and is the new pride and joy of Dr. Peter Crown, head of the remote sensing program at the University of Alberta soil sciences department.

"Ground analysis gives a worm's eye view, aerial photos give a bird's eye view. But Icarus gives a god's eye view," says Crown of the new system, installed last fall at the university.

The eye in the sky itself is the Landsat spacecraft, whose photographic images are brought to Earth by the Canadian government's sensing station at Prince Albert, Saskatchewan. The U of A in turn buys from the federal image bank, then feeds the magnetic tape to Icarus's brain, located on the fourth floor of the Soil Sciences building on campus.

Remote sensing systems such as this aren't new to Canada. Tidal power studies in the Bay of Fundy used similar techniques to estimate sediment buildup, and in New Brunswick remote sensing has been used to handle inventory for the province's potato acreage.

"It's the satellite's repetitive coverage that is its greatest value," says Crown. Aerial photographs giving the same coverage offer more resolution (you can see every fencepost on them) but "they would cost an awful lot more by comparison," says the U of A professor.

And Icarus has such big eyes. Each picture it takes covers 4,048 hectares of the province, showing how the land is being used, what kind of vegetation is growing where, and how much sediment is building up in rivers, streams and lakes — all part of what is technically termed 'gross environmental monitoring.'

Sometimes Icarus is an aerial policeman. Since the 1930s, for instance, wind erosion in the southern part of the prairies has been controlled through strip farming, with 40 strips to the hectare as a general rule of thumb. Icarus not only keeps tally of the number of strips to the hectare; it also keeps tabs on soil drifting in the area, supplying valuable data on the connections between land management and 'natural' wear and tear on the soil.

Icarus can also be watchdog over revegetation projects in areas where there has been strip-mining; it can monitor new vegetation growth following forest fires or the 'plume' effects of industrial plant smokestacks. (Icarus has already 'memorized' images of Fort McMurray from the area's pre-tarsands days.)

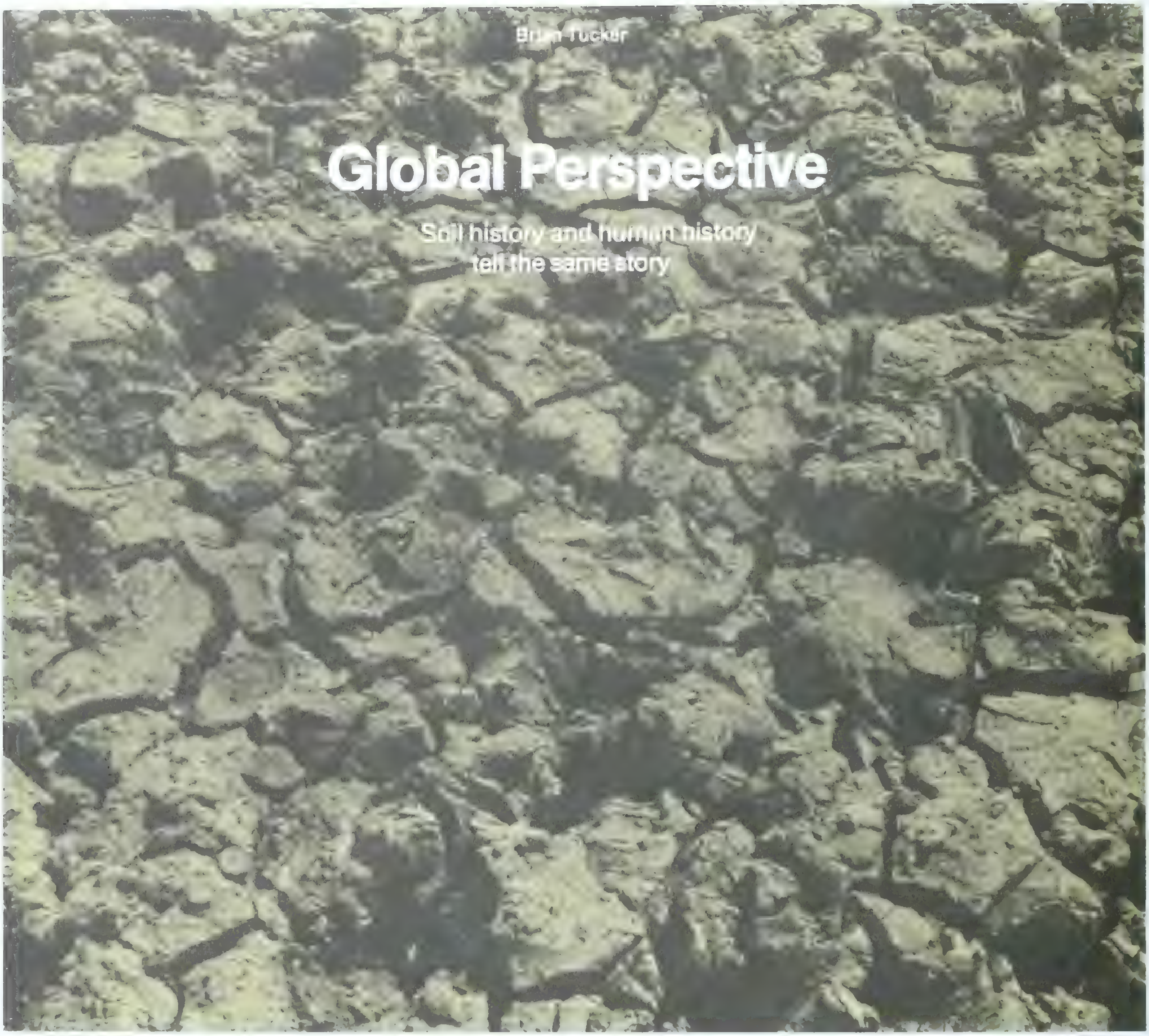
Crown isn't worried about the fate of the original Icarus being a bad omen. (Despite the warning of Daedalus his inventor-father, Icarus flew closer to the sun than his wax wings would allow and plunged to his death.) "We prefer to look upon Daedalus as a conservative type and Icarus as the one who took things a step further than was previously thought possible," he says.

David May is an Edmonton freelance writer.

Brian Tucker

Global Perspective

Soil history and human history tell the same story



We are losing ground — literally — in our struggle to feed hundreds of millions of hungry people.

The United Nations Environment Program says 300 million hectares — an area the size of four and a half Albertas — may be lost through soil erosion in the last quarter of this century. Another 300 million hectares may be consumed by expanding cities.

And vast areas will be rendered useless to agriculture, largely through mismanagement by man: over-grazing, over-cultivation, cutting down too many trees, increased salinity and silting from irrigation projects. With the world's population expected to grow by two billion by the year 2000, we can't afford to squander our most valuable resource — soil.

Many civilizations collapsed when their natural resources ran out. The exhaustion of soil in Italy, Sardinia, Sicily and Roman Africa contributed to the collapse of the Roman Empire. By the Peloponnesian War in 431-404 B.C., most of the Greeks' arable land was severely eroded because of over-cultivation and over-grazing. Greek civilization, dependant upon industry and foreign commerce, was doomed when Athens lost control of the seas and their industrial competitors caught up with them. Israel was once a fertile country but erosion scoured off so much soil that most of the land became barren. About 6,000 years ago, the Rajputana area in India was wooded and even marshy in parts. Today, largely because of human settlement and destruction of forests, it is desert.

"The littered ruins and barren landscapes left by former civilizations remind us that humans have been undercutting their own welfare for thousands of years," writes Erik Eckholm of the Worldwatch Institute. "What's new today is the environment is being destroyed on an awesome scale and at dizzying speed."

A prime example is the dustbowl created on the Great Plains of Canada and the United States during the 1930's. In 1934, the eastern U.S. was covered with a heavy fog composed of 350 million tonnes of topsoil swept up from the Plains into the transcontinental jet streams. Cattle died on parched land; families went broke by the thousands.

Hot, dry lands cover more than a third of the earth's surface. Where water has been diverted on to these lands, they have become extremely productive and densely populated, but usable land is being laid to waste by man and livestock. Deserts are creeping outwards in Africa, Asia and Latin America. And

Peter Roberts

worse, the productive capacity of vast semi-arid regions that border on the deserts — regions where almost 60 million people live — is shrinking.

In the early 1970s, drought and famine struck south of the Sahara desert in Africa. The nightmare of starving, stick-like human beings haunted our television screens. Though droughts cannot be predicted with precision, they should be expected from time to time in arid regions. It's essential to cut herds of grazing animals and halt the spread of cultivation when a few years of good rainfall lure desperate farmers on to marginal land.

This is easier said than done. An individual farmer with many mouths to feed sees little choice but to plough up high-risk fields. He also needs fuel to cook his food and keep warm at night. Half of mankind depends upon wood for fuel, and burns it in inefficient stoves; a peasant can use up to a tonne of wood a year. As the search for wood grows more difficult, peasants turn to crop wastes and dung for cooking and heating. This robs the soil of essential nutrients.

To reverse this cycle of despair, says economist Barbara Ward, we must increase non-human energy and the reliable flow of nutrients and water. 'Biogas' plants, after extracting biogas from waste matter for domestic cooking and heating, leave behind a safe dependable fertilizer for use in the fields. Efficient stoves and reforestation also lessen wood usage.

Mountain environments in poor countries are also deteriorating. Only 10 per cent of the world's population lives in highlands, but the future of another 40 per cent who live in the nearby lowland areas is tied to what happens on the slopes and plateaus above.

Nepal faces what may be the world's most acute soil erosion problem. Farmers are being forced on to steeper slopes unfit for farming, and villagers must as a result search farther from their homes for firewood and fodder. Topsoil washing down into India and Bangladesh is now Nepal's most precious — and regretted — export. India's severe floods of 1978 show the danger of barren hillsides and uncontrollable monsoons to the lowlands below.

The answer is to intensify food production on the best farmland in the lowlands and valleys, and on gentler mountain slopes. Where hillsides must be farmed to feed a growing population, soil conservation techniques are essential.

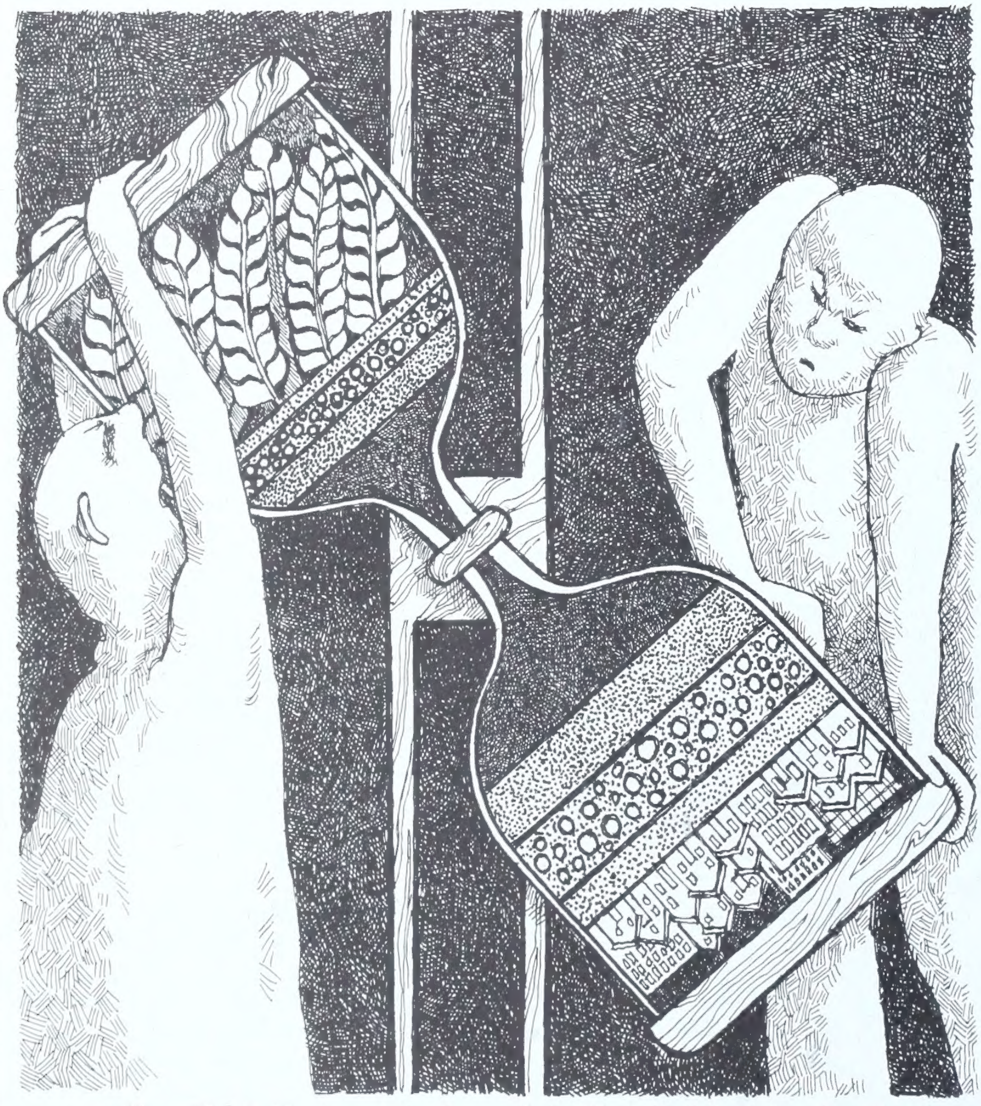
About 30 per cent of the world's food is produced from irrigated land. However, irrigation capacity is being lost to silt and salt.

Mesopotamia, on the plain of the Tigris and Euphrates rivers, is possibly the oldest irrigated area. The regions's soil fertility was once legendary; in its heyday 6000 years ago Mesopotamia supported between 17 and 25 million people. Today, modern Iraq has no more than 10 million people, and peasants eke out some of the world's lowest crop yields.

Here's what can happen. Dissolved salts in small amounts in all water do not evaporate, so as the water evaporates or is used by plants, the salt content of the remaining water increases. Irrigation waters unused by plants and not absorbed by air may seep down to the underground water table, which becomes more salty over time.

In Mesopotamia where there was no way to drain excess water, the water table started to rise. Seepage from canals and floods also added to ground water until it reached the roots, where its saltiness stunted or prevented crop growth.

As irrigation systems grew more complex, food production was also threatened by silt carried by the rivers into irrigation canals. A major lesson of Iraq's history is that irrigation and drainage can't be separated. *(Envi-*



Phil Hanniman — Sahakarini

ronment Views Vol. 3, No. 3, on irrigation salinity problems in the Colorado River basin.)

With year-round sun, warmth and rainfall, the huge potential of the humid tropics to produce vegetation seems obvious. What still eludes man is the means to harness it.

In most farmlands in temperate climates, the soil contains mineral nutrients to be used later by plants. In tropical forests, nutrients are locked in the dense, multi-layered vegetation; the soil merely props up vegetation. When land is stripped of its dense growth, soil temperature soars under the fierce equatorial sun, hastening biological activity and deterioration of remaining organic plant matter. Downpours wash away the thin topsoil and carry the few nutrients in the soil downward beyond crop roots.

Residents of tropical forests use a special tactic known as "shifting cultivation" to coax food from the land. When forest is cut away for cultivation, stumps and roots are left in the ground. This holds down erosion and provides for rapid forest regeneration after the plot is abandoned. Mixed cropping spreads harvesting efforts throughout the year, provides security in case one crop fails and reduces the chance of major losses from disease and insects.

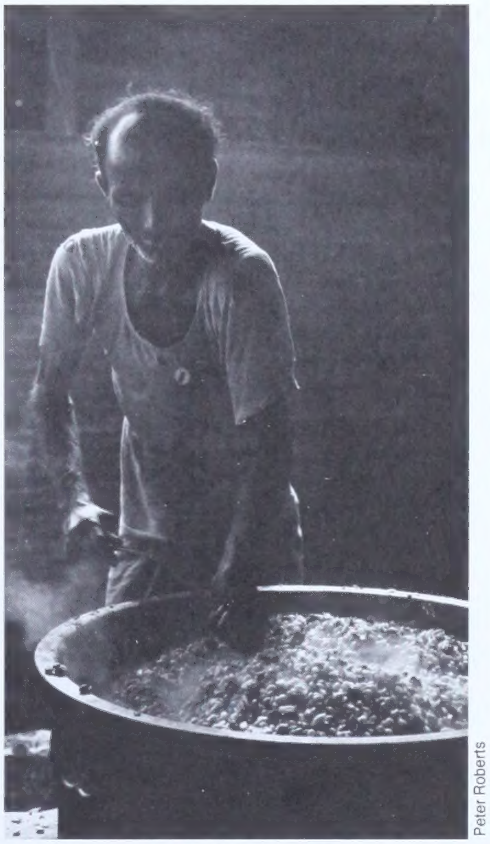
Crops produce well in the first growing season but the yield declines sharply after that. Soil fertility is depleted, thick weeds invade the plot and crop-eating insects multiply. Within two to five years of clearing, the plot is abandoned. Ideally, the plot is left

Phil Hanniman — Sahakarini

to rest from six to 20 years before the cycle of clearing and desertion are repeated. Shifting cultivation is well suited to tropical lands but will not provide enough of a yield to lift a farmer out of poverty.

As rising population puts pressure on these lands, people have adapted to increase the land's capacity. Southeast Asia, an intensive system of irrigated rice production has evolved over the centuries. In some of the savannas of West Africa and the highlands of East Africa, careful use of animal manures has permitted nearly continuous cultivation without great loss of soil fertility.

However, in other regions where population grows while the land available remains the same, the time allowed for land to regenerate between farming cycles is shortened. The deterioration of land gathers momentum. Africa's post-war population boom and the continuing of traditional farming methods means soil erosion and declining fertility could spread dramatically throughout much of that continent.


Peter Roberts

Why can't all our food be grown in vast areas of vats filled with gravel or sand and chemical solutions? Hydroponics, growing food without soils in sophisticated greenhouses, has become popular in several countries. The method permits automation, and every detail of the environment can be controlled.

Critics, however, say hydroponics may be fine for growing cash crops such as tomatoes and cucumbers in small-scale applications, but is not practical for growing a major part of the food for four billion people. 'Sea farming' likewise is an idea limited by cost and scale.

There is simply no escaping the fact that to ensure the survival of mankind and the protection of our planet's life-support system, we must conserve our soil.

Brian Tucker is an Edmonton journalist.

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Environment Update

Future Forests

Forests may become one of the world's most important reservoirs of carbon dioxide, say University of Alberta researchers Dr. Ken Higginbotham and Dr. J.M. Mayo.

Burning of fossil and other fuels releases large quantities of the gas into earth's atmosphere, and diffuses it worldwide. This could lead eventually to 'greenhouse effect' heating of the global surface — marginal areas could become desert, and polar ice caps could melt and inundate coastal cities. Earth's forests and oceans act as a 'sink' or reservoir for vital carbon dioxide, and widespread clearing of tropical forests may decrease this already diminished buffer. Unnecessary logging, even of commercially unimportant trees, should also be avoided in Canada.

Mayo and Higginbotham grew about 400 lodgepole pine seedlings last year to study the effects of elevated carbon dioxide levels on growth, and the role of trees in preserving earth-surface quantities of the gas. Their young trees seemed to put extra carbohydrates into their root systems, and sprouted unusually thick and wide leaves.

Soils Workshop

Our disappearing agricultural land is the main concern of the 1981 Alberta Soils Workshop, scheduled for February 24-25 in Edmonton's Terrace Inn.

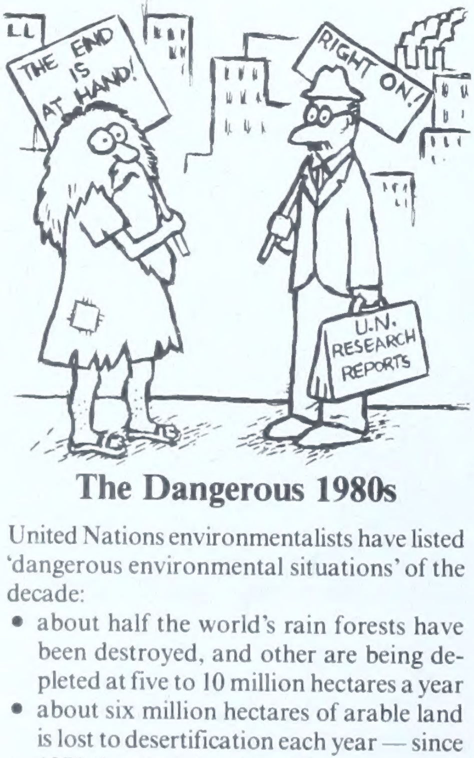
The symposium will attempt to put into perspective some of the factors affecting the land base, with emphasis on land degradation, and will address the effects of processes such as soil salinization, acidification, erosion, loss of organic matter, and agricultural management. Other discussion will focus on agricultural and non-agricultural land use.

Registration fee for the workshop is $45. For more information, contact T.M. Macyk, (403) 454-2290.

More Parks — But When?

Proliferation of new neighborhoods in Edmonton has park development running to catch up — but not fast enough yet.

More than $30 million a year for five years would be necessary to keep pace. General manager of Edmonton parks and recreation Hugh Monroe says his department faces a 'crisis situation' as new neighborhoods demand park facilities. He told the city's economic affairs committee that Edmonton now needs 67 new parks. Nine parks would be created with the requested parks and recreation budget for the coming year of $31.6 million.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U.N. RESEARCH REPORTS

The Dangerous 1980s

United Nations environmentalists have listed 'dangerous environmental situations' of the decade:

- about half the world's rain forests have been destroyed, and other are being depleted at five to 10 million hectares a year
- about six million hectares of arable land is lost to desertification each year — since 1970 the USA lost 12 million hectares to non-agricultural use while from 1960-70 Japan lost 7.3 per cent of its total agricultural land
- more than two-thirds of the world's fisheries, breeding grounds and coastal beaches are being degraded or destroyed
- perhaps 1,000 animal and 25,000 plant species are threatened with extinction
- earth's seas, atmosphere, soils and rivers are increasingly polluted by chemicals, hazardous wastes, carbon dioxide build-up and acid rain

In addition, our search for energy sources, for example coal liquification, could raise carbon dioxide levels still further. Fuel and food production may soon compete for agricultural land. Even remote areas such as Antarctica are in danger of over-exploitation.

Is there any solution? International co-operation, says the UN, can still reverse the dangerous trend.

Northern Seminar

Environmental implications of northern development will be the topic of a seminar at the Banff Centre School of Management March 8-16.

Aspects of northern development under consideration will be renewable and non-renewable resource options, resource value assessment and economic versus environmental cost-benefit analysis.

Resource people will include economists, energy experts, biologists and others with experience in the development of Canada's arctic and sub-arctic regions. Among the participants will be representatives of federal and provincial governments, industry and research, as well as people with professional or personal interest in the north.

Further information is available from the Banff Centre School of Management, Box 1020, Banff T0L 0C0, (403) 762-3391.

If you have a short news item of province-wide interest you'd like to contribute to Environment Update, please send it to the editor at the address on the Contents page. The editor reserves the right to select and edit the items.